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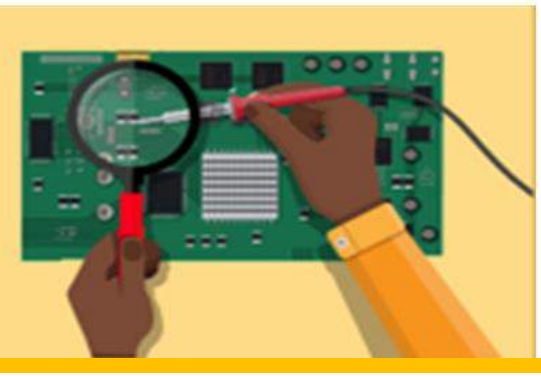

CSAPA301

COMPUTER SYSTEM AND ARCHITECTURE

Computer PCB and System Assembling

TRAINEE'S MANUAL

October, 2024

COMPUTER PCB AND SYSTEM ASSEMBLING

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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TABLE OF CONTENT

ACRONYMS

ESD: Electrostatic Discharge

KOICA: Korean international corporation Agency

LED: Light emitting diodes

PCB: Printed Circuit Board

PCBA: Printed Circuit Board Assembly

POST: Power On-Self Test

PPE: Personal protective Equipment

RTB: Rwanda TVET Board

SMD: Surface Mount Devices

SMT: Surface Mount Technology

SOP: Standard of Product

THT: Through Hole Technology

TQUM: TVET Quality Management Project

INTRODUCTION

This trainee's manual includes all the knowledge and skills required in computer system and architecture specifically for the module of **" Computer PCB and System Assembling."** Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies.

The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

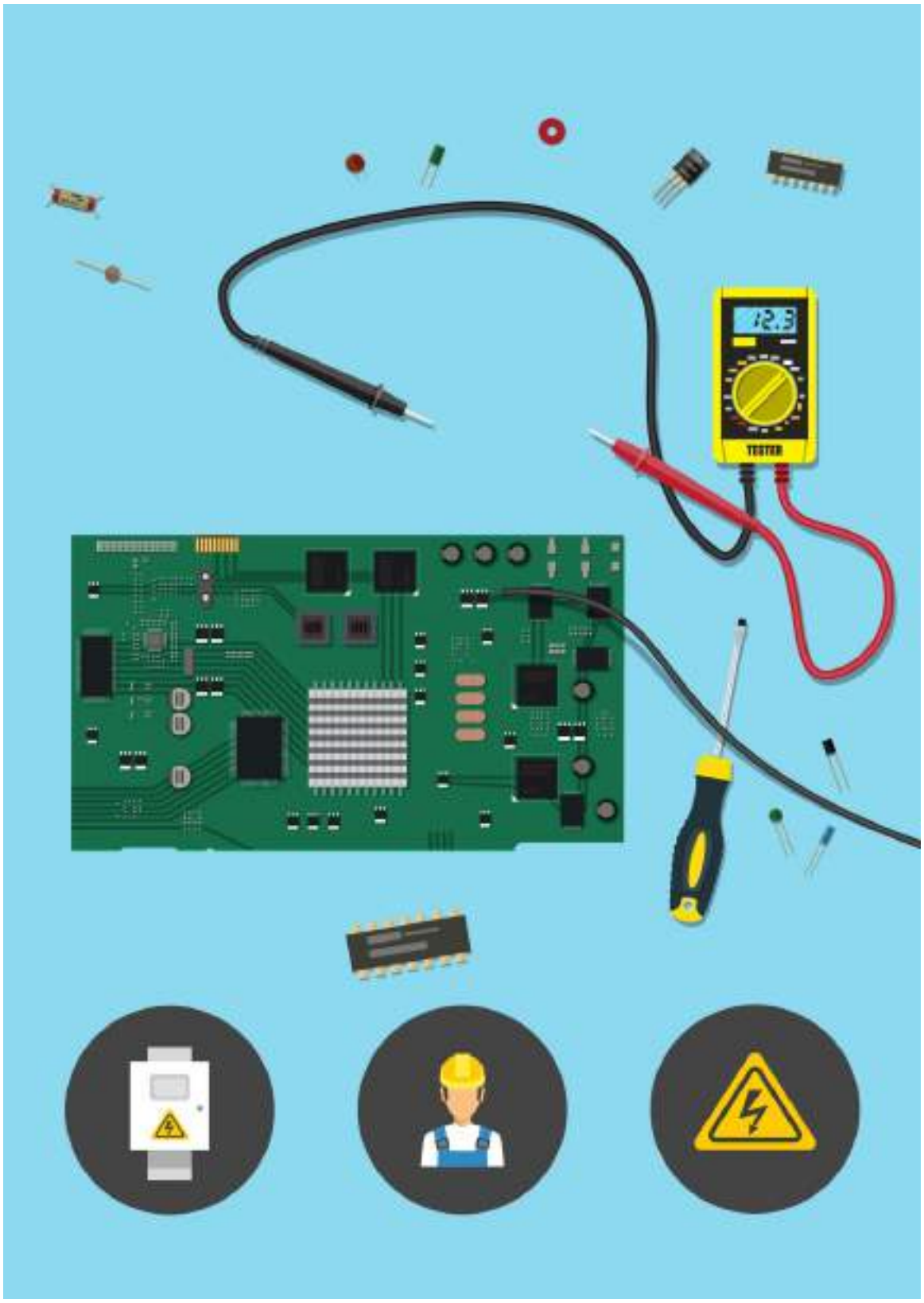
The trainee's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainee, you will start by addressing questions related to the activities, which are designed to foster critical thinking and guide you towards practical applications in the labor market. The manual also provides essential information, including learning hours, required materials, and key tasks to complete throughout the learning process.

All activities included in this training manual are designed to facilitate both individual and group work. After completing the activities, you will conduct a formative assessment, referred to as the end learning outcome assessment. Ensure that you thoroughly review the key readings and the 'Points to Remember' section.

MODULE CODE AND TITLE: CSAPA301 COMPUTER PCB AND SYSTEM ASSEMBLING

Learning Outcome 1: Prepare Tools, material and Equipment
Learning Outcome 2: Assemble PCB using SMT
Learning Outcome 3: Connect computer system parts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Indicative contents
1.1. Introduction to computer system assembly
1.2. Preparation of workplace
1.3. Identification of tools, materials and equipment
1.4. Calibration of equipment

Key Competencies for Learning Outcome 1: Prepare Tools, material and Equipment

Knowledge	Skills	Attitudes
• Description of PCBA • Description of computer components • Description of working environment • Identification of hazards • Description of equipment calibration	• Setting up working environment • Applying Safety Procedures • Selecting tools, materials and equipment • Applying of Calibration procedures	• Having Attention to detail • Being Patience and perseverance • Having Safety-consciousness • Having Problem-solving mindset • Being Openness to learning

Duration: 10 hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Prepare properly Workplace according to the work to be done.
2. Select correctly Tools, materials and equipment according to the given task and specifications.
3. Calibrate effectively Equipment according to the task to be done

Resources

Equipment	Tools	Materials
● SMT Line (SMT Loader, Solder Paste Mixer, Solder Paste Printing Machine, Solder Paste Inspection machine (SPI), Pick and Place Machine, Reflow Machine) ● Automatic Optical Inspection (AOI) ● X-Ray inspection machine ● ESD Tester ● PPEs ● Soldering Station ● wave soldering machine ● solvent cleaning equipment	● Hand tools ● Diagnostic tools ● ESD tools	● SMD ● PTH components ● Solder Paste ● deionized water ● PCB ● SMT adhesive ● soldering flux ● soldering wire

Indicative content 1.1: Introduction to Computer System Assembly

Duration: 2 hrs

Theoretical Activity 1.1.1: Introduction to computer system assembly

Tasks:

1: You are requested to answer the following questions related to the Introduction to Computer system assembly

i. Differentiate PCB from PCBA
ii. Define the following terms
    a. Soldering
    b. Computer
    c. Computer system
    d. Computer assembly
iii. What is computer hardware?
iv. Identify at least five hardware components that runs through the Motherboard

2: Provide the answers for the asked questions and write them on provided flipchart or papers.

3: Discuss on the provided answers and choose correct answers

4: Ask questions and more clarification where it is necessary.

5: Read the **key readings 1.1.1.**

Key readings 1.1.1: Introduction to computer system assembly

1.1. Printed Circuit Board Assembly (PCBA)

1.1.1. Key terms

•PCB (Printed Circuit Board)

Definition: A PCB is a flat board made of insulating material that serves as a foundation for connecting and supporting electronic components. It has conductive pathways etched onto its surface.

Purpose: The primary function of a PCB is to physically hold components and provide electrical connections between them.

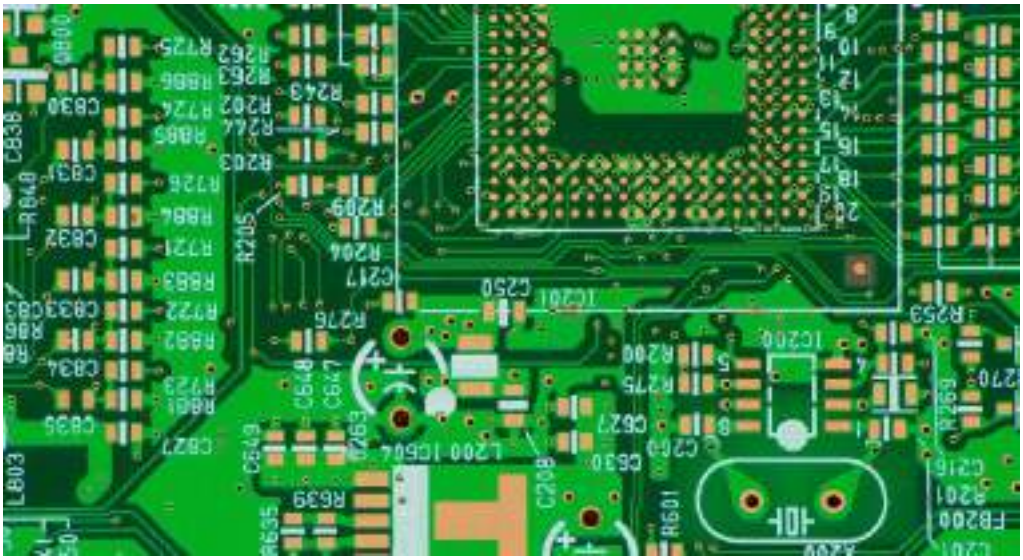
Components: A PCB can exist without any components; it is essentially a bare board.

•PCB Assembly

✓ **Definition**: PCB assembly is the process of placing and soldering electronic components on a PCB to create a functional electronic device.

✓ **Purpose**: The goal of PCB assembly is to integrate the necessary components so that the PCB can perform its designed function.

✓ **Components**: Involves various electronic components (resistors, capacitors, ICs, etc.) being mounted and soldered onto the PCB.



•**Soldering:** Soldering is a process in which electronic components are joined to a printed circuit board using a metal alloy known as solder. Solder has a relative low melting point (e.g. lower than the adjoining metals). When solder is heated up beyond its melting temperature it melts. When it cools down it create an electrical bond known as solder joint.

2. Computer assembly

- A **computer**

Is a device or a tool that accepts data and processes it into another form. In other word a computer is a machine, which stores and manipulates data in a logical manner.

It is also defined as an electronic device that accepts data as input, and transforms it under the influence of a set of special instructions called Programs, to produce the desired output (referred to as Information)

- Computer **System**:

Is a collection of entities (hardware and software) that are designed to receive, process, manage and present information in a meaningful format.

A computer system consists of hardware components that have been carefully chosen so that they work well together and software components or programs that run in the computer.

- **Computer hardware**

Computer hardware is the physical components that a computer system requires to function. It encompasses everything with a circuit board that operates within a PC or laptop; including the motherboard, graphics card, CPU (Central Processing Unit), ventilation fans, webcam, power supply, and so on.

- **Motherboard**

The motherboard houses the CPU and is a hub that all other hardware runs through. The motherboard acts as a brain, allocating power where it's needed, communicating with and coordinating across all other components that making it one of the most important pieces of hardware in a computer.

When choosing a motherboard, it's important to check what hardware ports the motherboard supplies. It's vital to check how many USB ports, and what grade (USB 2.0, 3.0, 3.1) they are, as well as what display ports are used (HDMI, DVI, RGB) and how many of each there are. The ports on the motherboard will also help you define what other hardware will be compatible with your computer.

Although the motherboard is just one piece of circuitry, it is home to another one of the most important pieces of hardware: the processor.

- **Central Processing/Processor Unit (CPU)**

CPU stands for Central Processing Unit. This is the part of a computer that handles the data and activities of the various physical components of the computer. It transfers instructions between a computer's hardware and software. It is also known as a processor, microprocessor, or central processor. Inputs enter a computer and travel to the CPU. The CPU executes the instructions and delivers the results to the associated output. Basically, the CPU is the brain of a computer. It takes in the necessary information and processes it, thus allowing the computer to function.

• **RAM (Random Access Memory)**

Random Access Memory, or RAM, is hardware found in the memory slots of the motherboard. The role of RAM is to temporarily store on-the-fly information created by programs and to do so in a way that makes this data immediately accessible.

•**Hard Drive**

The hard drive is a storage device responsible for storing permanent and temporary data. This data comes in many different forms, but is essentially anything saved or installed to a computer: for example, computer programs, family photos, operating system, word-processing documents, and so on.

There are two different types of storage devices: the traditional hard disk drive (HDD) and the newer solid-state drives (SSD). Hard disk drives work by writing binary data onto spinning magnetic disks called platters that rotate at high speeds, while a solid-state drive stores data by using static flash memory chips.

•**Graphics Processing Unit (GPU)**

Especially important for 3D rendering, the GPU does exactly what its name suggests and processes huge batches of graphic data. You will find that your computer's graphics card has at least one GPU.

•**Power Supply Unit (PSU)**

A power supply unit, commonly abbreviated as PSU, does more than just supply your computer with power. It is the point where power enters your system from an external power source and is then allocated by the motherboard to individual component hardware. Not all power supplies are made equally however, and without the right wattage PSU your system will fail to work.

Without the right amount of power, components won't be able to run effectively and the computer might experience crashes or simply fail to boot at all. It's recommended to have a power supply that more than covers your system usage.

Points to Remember

- A PCB is a flat board made of insulating material that serves as a foundation for connecting and supporting electronic components.
- PCB assembly is the process of placing and soldering electronic components on a PCB to create a functional electronic device.
- Computer is a device or a tool that accepts data and processes it into another form.
- A computer system consists of hardware components that have been carefully chosen so that they work well together and software components or programs that run in the computer.
- Computer hardware is the physical components that a computer system requires to function

Application of learning 1.1.

Company AKI is a retail store specializing in computers. As part of their operations, the company intends to assemble computers in-house before selling them. You are requested to select the best computer hardware components necessary for the assembly process.

Indicative content 1.2: Preparation of Workplace According to Work to be done

Duration: 2 hrs

Theoretical Activity 1.2.1 Description of working environment

Tasks:

1. You are requested to answer the following questions related to the description of working environment
   i. Is it important to set properly working environment? Justify your answer
   ii. Identify at least three (3) characteristics of working environment
   iii. Identify at least three (3) classification of chemical hazards
   iv. Describe Hazard Control Measures
2. Discuss on the given tasks
3. Present the findings to the whole class.
4. In addition, ask for clarification where necessary.
5. For more clarification, read the **key readings 1.2.1**

Key readings 1.2.1: Description of working environment

Safe working conditions help prevent injury to people and damage to computer equipment. A safe workspace is clean, organized, and properly lighted. Everyone must understand and follow safety procedures.

All PPE clothing and equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion. School should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace. PPE that fits well and is comfortable to wear will encourage Trainees/Trainer use of PPE. Most protective devices are available in multiple sizes and care should be taken to select the proper size for each Trainees/Trainer. If several different types of PPE are worn together, make sure they are compatible.

Apply Safety Procedures

Personal Protective Equipment (PPE):

- Eye Protection: Wear safety glasses or goggles to shield your eyes from flying debris, solder splatter, or other hazards.
- Hand Protection: Use ESD-safe gloves when handling sensitive components to avoid static discharge.

- Respiratory Protection: Consider using a respirator or fume extractor when working with solder to minimize exposure to fumes.
- Clothing: Wear comfortable, non-loose clothing that covers your arms and legs. Avoid wearing jewelry or accessories that could interfere with your work.

Electrical Safety: Unplug the soldering iron when not in use and be mindful of electrical hazards when working with powered equipment.
Housekeeping: Maintain a clean and organized work area to prevent tripping hazards or the loss of small components.
Waste Disposal: Properly dispose of any hazardous materials, such as used solder, in accordance with local regulations.
Emergency Preparedness: Know the location of fire extinguishers, first aid kits, and emergency exits in your workspace.

Identify and Classify Hazards

Types of Hazard

Workplace hazards fall into six core types – safety, biological, physical, ergonomic, chemical and workload.

1) Safety hazards

Safety hazards can affect any employee, but these are more likely to affect those who work with machinery or on a construction site. Safety hazards include slips, trips and falls, operating dangerous machinery and electrical hazards.

2) Biological hazards

Biological hazards are extremely dangerous. These include exposure to dangerous substances and diseases associated with working amongst animals, people, or infectious plant materials. Employees who work in hospitals, laboratories or various other outdoor occupations are at risk from biological hazards.

3) Physical hazards

Physical hazards can affect those who work in extreme weather conditions or in harmful environments. Workers who are exposed to continuous loud noise, radiation, sun rays and ultraviolet rays could be at risk.

4) Ergonomic hazards

Ergonomic hazards affect individuals whose work puts a strain on their bodies. Manual roles that require lifting or sitting for long periods can cause damage over time. These hazards may not be noticeable at first which makes them much harder to identify. If your staff use improperly adjusted workstations or have poor posture when performing manual roles and heavy lifting, they may be at risk of injury.

5) Chemical hazards

Chemical hazards mainly threaten employees whose roles expose them to dangerous liquids, solvents or flammable gases. Individuals who are most likely to be affected are those working in cleaning facilities, engineers and employees in field-based roles. Exposure to harmful chemicals can cause illness, skin irritation, breathing problems and, in extreme cases, death.

6) Workload hazards

Workload hazards include issues that could cause stress or strain, such as workload, violence or aggression. These hazards can be experienced in any job role. However, lone workers may struggle to voice concerns due to their isolated work environment or find themselves a target for anti-social behaviour.

Implement Hazard Control Measures

Use the hierarchy of controls to remove or reduce risk in your workplace. It starts with the most effective control method (removing the hazard from your workplace completely) and finishes with the least effective (wearing personal protective equipment/PPE).

1 Eliminate the hazard

Remove it completely from your workplace. For example: repair damaged equipment; outsource processes involving hazardous chemicals or equipment to a company set up to manage them safely. *If this is not practical, then…*

2 Substitute the hazard

Replace it with a safer alternative. For example: use a less toxic chemical; lift smaller packages. *If this is not practical, then…*

3 Isolate the hazard

Keep it away from workers as much as possible. For example: relocate photocopiers to separate, ventilated rooms; install barriers to restrict access to hazardous work areas. *If this is not practical, then…*

4 Use engineering controls

Adapt tools or equipment to reduce the risk. For example: place guards on dangerous parts of machinery; use a trolley for moving heavy loads. *If this is not practical, then…*

5 Use administrative controls

Change work practices and organisation. For example, rotate jobs to reduce the time spent on any single work task; train staff in safe work procedures; carry out routine maintenance of equipment. *If this is not practical, then…*

6 Use personal protective equipment (PPE)

For example: use hearing/eye protection equipment, hard hats, gloves and masks; train staff to use PPE correctly.

Characteristics of good working environment

1. Work Area: Choose a clean, well-lit, and spacious work surface, such as a sturdy workbench or table. Ensure the area is free from clutter and potential tripping hazards.

2. Lighting: Provide ample, even lighting across the work area, either through overhead fixtures or a dedicated task lamp. Good lighting is essential for detailed work.

3. Ventilation: Ensure proper ventilation to prevent the buildup of fumes from soldering or other activities. Open windows or use a dedicated ventilation system like fan.

Practical Activity 1.2.2: Setting Working Environment

Task:

1. Referring to **key reading (1.2.2)** , you are requested to perform the given task. The task should be done **individually.**
   Establish a safe and organized workspace for assembling desktop computers. Ensure that the area is well-structured to facilitate efficient assembly
2. Follow how to set good working environment.
3. Receive the other tasks required to set good working environment.
4. Present the findings to the whole class
5. Read key reading 1.2.2 in the trainee manual.

Key readings 1.2.2: Setting Working Environment

A **working environment setup** is a critical foundation for ensuring efficiency, productivity, and safety in any task or industry. Whether in an office, workshop, or laboratory, creating a well-organized, functional space tailored to the specific requirements of the work is essential. A well-thought-out workspace not only

enhances workflow but also promotes focus, reduces errors, and improves overall job satisfaction.

Procedures to be followed to create a safe working Environment

1. **Define the Purpose**: Understand the specific tasks and requirements of the workspace.
2. **Choose the Location**: Select an appropriate space with adequate size, ventilation, and lighting.
3. **Organize Tools and Equipment**: Arrange essential tools and devices for easy access.
4. **Establish Ergonomics**: Set up desks, chairs, and workstations for comfort and efficiency.
5. **Ensure Safety Measures**: Implement safety protocols, including fire safety, first-aid, and protective equipment.
6. **Install Proper Lighting and Ventilation**: Ensure adequate lighting and air circulation.
7. **Create a Clean and Clutter-Free Space**: Maintain a tidy, organized area to improve focus and productivity.
8. **Set Up Storage Solutions**: Use shelves, cabinets, or containers to store materials and tools.
9. **Integrate Power and Connectivity**: Ensure adequate power outlets, internet access, and other necessary connections.
10. **Review and Adjust**: Review the setup, make necessary adjustments for comfort and functionality.

Points to Remember

- Safe working conditions help prevent injury to people and damage to computer equipment. A safe workspace is clean, organized, and properly lighted. Everyone must understand and follow safety procedures.
- Wear Personal Protective Equipment (PPE) to apply Safety Procedures
- Workplace hazards fall into six core types – safety, biological, physical, ergonomic, chemical and workload.
- Use the hierarchy of controls to remove or reduce risk in your workplace. It starts with the most effective control method (removing the hazard from your workplace completely) and finishes with the least effective (wearing personal protective equipment/PPE).
- **Steps followed to create a safe working Environment**

1. Define the Purpose
2. Choose the Location
3. Organize Tools and Equipment
4. Establish Ergonomics
5. Ensure Safety Measures
6. Install Proper Lighting and Ventilation
7. Create a Clean and Clutter-Free Space
8. Set Up Storage Solutions
9. Integrate Power and Connectivity
10. Review and Adjust

Application of learning 1.2

Company XYZ specializes in setting up LED TVs for small institutions and needs to prepare a safe and efficient workspace for assembling various TV hardware components. Your task is to create this assembly environment, ensuring that safety procedures are prioritized.

Indicative content 1.3: Identification of Tools, Materials and Equipment

Duration: 4 hrs

Theoretical Activity 1.3.1 Identification of tools, materials and equipment for PCB and computer assembly

Tasks:

1. you are requested to answer the following questions related to the Identification of tools, materials and equipment

   i. Define SMT
   ii. Outline at list five (5) advantages of using the SMT line
   iii. Differentiate Flat-head screwdriver, Phillips-head screwdriver**,** Torx screwdriver**,** Hex driver and Needle-nose pliers
   iv. Is it important to use PPE's while working with computer and PCB assembling? Justify your answer
   v. Outline two ESD tool used in computer and PCB assembling
   vi. Name the following diagnostic tool and provide its functions

   vii. What criteria would you follow when selecting tools, material and equipment?

2. Discuss on the given tasks
3. Present the findings to the whole class.
4. In addition, ask questions where necessary.
5. For more clarification, read the **key readings 1.3.1**

Key readings 1.3.1: Identification of tools, materials and equipment for PCB and computer assembly

Identification tools, material and equipment for PCB and computer assembly

1. SMT Line

SMT is an abbreviation of the word **Surface Mount Technology**. refers to the method of mounting electronic components directly into the surface of printed circuit boards (PCBs).

Advantages of using the SMT line

- **Smaller Components**: Surface mount devices are significantly smaller and lighter, allowing for more compact and slim PCB designs, optimizing space and weight.
- **Flexible Design**: SMT allows for a wide range of PCB materials and designs, making flexible and rigid-flex PCBs possible, offering more versatility in product development.
- **Automated Production**: SMT eliminates manual lead insertion, bending, and cutting, enabling a more efficient, automated manufacturing process that reduces human error.
- **Improved Signal Performance**: Shorter leads in SMT reduce RF interference, allowing faster signal transmission, better performance at high frequencies, and greater resistance to vibration and noise.

2. Hand Tools

Most tools used in the computer assembly process are small *hand tools*. They are available individually or as part of a computer repair toolkit. Toolkits range widely in size, quality, and price. Some common hand tools and their uses are:

- **Flat-head screwdriver:** Used to tighten or loosen slotted screws.
- **Phillips-head screwdriver:** Used to tighten or loosen cross-headed screws.
- **Torx screwdriver:** Used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.
- **Hex driver:** Used to tighten or loosen nuts in the same way that a screwdriver tightens or loosens screws (sometimes called a nut driver).
- **Needle-nose pliers:** Used to hold small parts.
- **Wire cutters:** Used to strip and cut wires.
- **Tweezers:** Used to manipulate small parts.
- **Part retriever:** Used to retrieve parts from locations that are too small for your hand to fit.
- **Flashlight:** Used to light up areas that you cannot see well.
- **Wire stripper:** A wire stripper is used to remove the insulation from wire so that it can be twisted to other wires or crimped to connectors to make a cable.
- **Crimper:** Used to attach connectors to wires.
- **Punch-down tool:** Used to terminate wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.

3. ESD tools

Short for electrostatic discharge, ESD is one of the few things you can do to damage or destroy your computer or parts in your computer. Like the shock you receive when rubbing your feet on the carpet and touching something metal, ESD can occur when working in your computer and can cause damage to components. ESD can occur without you feeling a shock and only occurs while working inside a computer or handling an expansion card or other hardware.

ESD Tools

There are two ESD tools: the antistatic wrist strap and the antistatic mat. The **antistatic wrist strap** protects computer equipment when grounded to a computer chassis.

The antistatic mat protects computer equipment by preventing static electricity from accumulating on the hardware or on the technician.

The best method of preventing ESD is to use an ESD wrist strap, grounding mat, or grounding workbench. However, because most users don't have such items, we've included the following steps to reduce the chances of ESD as much as possible.

- **Zero potential** - Most importantly, make sure you and the computer are at zero potential by continuously touching an unpainted metal surface of the chassis or the computer power supply case.
- **Standing -** Always be standing when working inside the computer. If you are sitting on a chair or the floor, it can generate more electrostatic.
- **Cords -** Disconnect everything from the back of the computer (e.g., power cord, monitor, and USB cables).
- **Clothes** - Make sure not to wear any clothing that conducts an electrical charge, such as a wool sweater.
- **Weather** - Electrical storms can increase the ESD risk; if it can wait, try not to work on a computer during an electrical storm.
- **Accessories** - To help reduce ESD and help prevent other problems, it is also a good idea to remove all jewelry.
- **Surface -** Standing on a hard surface, and the computer or other electrostatic sensitive devices should be on the table.

4. Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) products are used to guard persons against injury from acute or chronic environmental hazards. Example products include earplugs and muffs, anti-fatigue mats, face shields and protective eyewear, hard hats, helmets, respirators, safety harnesses, gloves, heat-resistant blankets, high-visibility clothing, etc

5. Cleaning tools

Clean cloth

A cloth is a good tool for cleaning unlike paper towels, they shouldn't leave lint or other paper debris after you wipe down your computer. The cloth should be lint free and will be good for wiping down any surface of your computer.

Compressed Air

A can of compressed air will help you remove any packed in dust from your computer's fan and any other hard to reach crevices. All you have to do is blow the air into the crevice to loosen the particles from your computer.

Isopropyl Alcohol

For computer cleaning you can use either pure isopropyl alcohol or 90 percent to 70 percent isopropyl alcohol. Just make sure not to use an ethanol based alcohol. The alcohol will help clean germs from your computer.

Cotton Swabs

Cotton swabs are handy for cleaning in hard to reach places on your computer. Just dip the cotton swabs into the isopropyl alcohol and use them to clean areas where the cloth won't reach.

6. Diagnostic tools and equipment

•Software tools

Windows Performance Monitor: Comprehensive system monitoring tool to track CPU, memory, disk, network, and application performance.

Windows Resource Monitor: Detailed real-time view of system resource usage, including processes, CPU, memory, disk, and network.

CPU-Z: Hardware information utility that provides low-level details about your computer's processor, motherboard, and memory.

•Hardware Diagnostic Tools

Hardware diagnostic tools are used to test and diagnose equipment.

It includes the following:

A digital multimeter: a device that can take many types of measurements. It tests the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.

A loopback adapter, also called a **loopback plug**, tests the basic functionality of computer ports. The adapter is specific to the port that you want to test.

The toner probe, is a two-part tool. The toner part is connected to a cable at one end using specific adapters, such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.

7. SMD components

SMT is surface mounted technique that is used for the creation of projects on the PCB board. The components created with the use of SMT technique is called **SMD components.**

Surface Mount Devices or SMDs are components that manufacturers and technicians use to mount on SMT PCBs.

- Types of SMD components

- o Chip Resistors (R)
- o Network Resistor (RA/RN)
- o Ceramic Capacitors (C)
- o Diode (D)
- o LED
- o Transistors (Q)
- o Inductors

8. Plated through-hole (PTH)components

The most common type of components used for hand soldering is PTH components. PTH components have wires, or leads, coming out of the sides or bottom allowing you to solder them into a circuit, or stick into a breadboard. PTH components are called "through-hole" because the leads are normally inserted through a copper plated hole in a PCB and soldered to fix it in place.

9. Soldering equipment

Soldering is a joining process used to join different types of metals together by melting solder. Solder is a metal alloy usually made of tin and lead which is melted using a hot iron. The iron is heated to temperatures above 600 degrees Fahrenheit which then cools to create a strong electrical bond.

Soldering Equipment:

•**Soldering Iron**: This is the primary tool used for soldering. It comes in various wattage ratings and tip shapes to suit different applications.

- **Soldering Station**: A soldering station includes a soldering iron, a temperature-controlled power supply, and sometimes additional features like a sponge or brass wool to clean the iron tip.
- **Solder Wire**: This is the material that is melted and used to create the electrical connection. Common types include lead-based and lead-free solder.
- **Solder Sucker/Desoldering Pump**: Used to remove excess solder from a joint.
- **Helping Hands**: A tool with adjustable arms and clips to hold components in place during soldering.
- **Flux Pen/Paste**: Helps clean the surfaces and improve solder flow.
- **Sponge/Brass Wool**: Used to clean the soldering iron tip.

10. Soldering Materials:

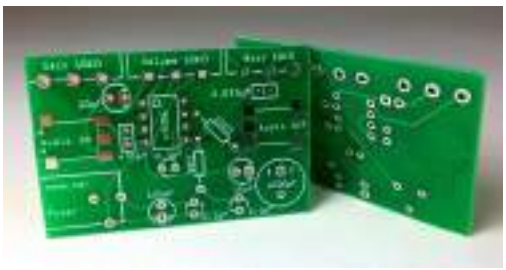
1. **Printed Circuit Boards (PCBs)**: The base on which electronic components are mounted and soldered.
2. **Electronic Components**: Such as resistors, capacitors, integrated circuits, and connectors.
3. **Flux**: Helps remove oxidation and improve solder wetting.
4. **Solder Wick**: A braided copper wire used to remove excess solder.
5. **Heat Shrink Tubing**: Used to insulate and protect soldered connections.
6. **Jigs and Clamps**: Helps hold components in place during soldering.
7. **Fume Extractor**: Removes fumes and particles generated during soldering.

11. PCB

A printed circuit board (PCB) is the board base for physically supporting and wiring the surface-mounted and socketed components in most electronics.

Printed Circuit Boards (PCBs) form the backbone of all major electronics. These miraculous inventions pop up in nearly all computational electronics, including simpler devices like digital clocks, calculators etc. For the uninitiated, a PCB routes electrical signals through electronics, which satisfies the device's electrical and mechanical circuit requirements. In short, PCBs tell the electricity where to go, bringing your electronics to life

PCBs direct current around their surface through a network of copper pathways. The complex system of copper routes determines the unique role of each piece of PCB circuit board.



Practical Activity 1.3.2: Selecting Tools, Materials, and Equipment

Task:

1. Referring to **key reading (1.3.1)** and **key reading (1.3.2)** , you are requested to Read the given task. The task should be done **individually**.

Select the necessary tools, materials, and equipment required for assembling new desktop computers. Ensure that the selection includes essential items such as SMT lines, hand tools, ESD tools, and personal protective equipment (PPE). Additionally, consider incorporating cleaning tools, diagnostic equipment, SMD components, PTH components, soldering tools, soldering materials, and solvent cleaning equipment to facilitate a smooth and efficient assembly process.

2. List out procedures followed to perform the given task
3. Referring to procedures provided above, Perform the required task
4. Present your work to the whole class

Key readings 1.3.2: Selecting Tools, Materials, and Equipment

Selecting Tools, Materials, and Equipment for Computer PCB and System Assembly

When assembling computer systems and PCBs (Printed Circuit Boards), choosing the right tools, materials, and equipment is essential for ensuring efficiency, precision, and the long-term reliability of the final product. The selection process requires a clear understanding of the components involved and the tasks to be performed. Proper selection minimizes errors, enhances safety, and ensures that the assembly process runs smoothly, whether you're working with delicate PCBs or building a full computer system.

Steps to Follow When Selecting Tools, Materials, and Equipment

1. **Understand the Task Requirements**
   Identify whether you're assembling a computer system, working with PCBs, or both, and assess the specific needs of each task.
2. **Select Essential Tools**:
   - **For PCB Assembly**:
     - Soldering Iron**:** Adjustable temperature for precise soldering.
     - Soldering Wire and Flux**:** For connecting components to the PCB.
     - Tweezers: For handling small components.
     - ESD Wrist Strap and Mat**:** To prevent electrostatic discharge damage.
   - **For System Assembly**:
     - Screwdrivers**:** Preferably magnetic Phillips-head for assembling components.
     - Anti-static Wrist Strap: To protect system components from static electricity.
     - Cable Ties and Cutters: For organizing cables inside the case.
3. **Choose Appropriate Materials**:

- For PCB**:** Select the right type of PCB (single-layer or multi-layer) and the necessary electronic components (resistors, capacitors, ICs).
- For System Assembly**:** Choose components like the motherboard, CPU, RAM, storage devices, and power supply that are compatible with each other.

4. **Ensure Compatibility of Components**:
   Verify that the selected motherboard, CPU, RAM, GPU, and other parts are compatible in terms of size, power requirements, and performance needs.
5. **Choose Testing and Diagnostic Equipment**:

- Multimeter: For testing circuit connections and power levels.
- Oscilloscope**:** For signal testing on PCBs.
- Power Supply Tester**:** To check the functionality of the PSU in system assembly.

6. **Implement ESD Protection**:

   Use **anti-static mats**, **wrist straps**, and proper grounding procedures to safeguard sensitive components.

7. **Consider Safety Equipment**:

- Safety Goggles**:** For protection when soldering or working with power tools.
- Ventilation**:** Ensure proper airflow, especially when soldering, to avoid harmful fumes.

Points to Remember

Identification of tools, materials and equipment

✓ SMT line

✓ Hand tools
✓ ESD tools
✓ Personal Protective Equipment (PPE)
✓ Cleaning tools
✓ Diagnostic tools and equipment
✓ SMD components
✓ PTH components
✓ Soldering equipment
✓ Soldering materials
✓ Solvent cleaning equipment
✓ PCB

Steps followed to select tools, materials and equipment

1. Understand the Task Requirements
2. Select Essential Tools
3. Choose Appropriate Materials
4. Ensure Compatibility of Components
5. Choose Testing and Diagnostic Equipment
6. Select Appropriate Cables and Connectors
7. Implement ESD Protection
8. Consider Safety Equipment

Application of learning 1.3

Company MDD has been assigned the task of assembling PCBs and computers for sale. As a computer system assembly technician, you are hired for selecting the necessary tools, materials, and equipment required to assemble the PCBs for the new computers.

Indicative content 1.4: Description Equipment Calibration

Duration: 2 hrs

Theoretical Activity 1.4.1: Description of Equipment Calibration

Tasks:

1 you are requested to answer the following questions related to the Description of Equipment Calibration

i. What is equipment calibration?
ii. Outline two categories for calibrating equipment
iii. Differentiate three (3) types of Equipment Calibration

2. Present the findings to the whole class.

3. For more clarification, **read the key readings 1.4.1**

4. In addition, ask questions where necessary.

Key readings 1.4.1: Description of Equipment Calibration

Equipment Calibration

Equipment calibration is the process of checking and adjusting the accuracy of an instrument by comparing its readings with a standard reference. This ensures that the instrument's measurements are accurate and reliable. Proper calibration is essential for maintaining precision and involves fine-tuning the instrument to match the established standards. A well-executed calibration program is important for ensuring consistent and precise readings.

There are two main categories for calibrating equipment:

- **Absolute calibration** is where you compare the reading of your instrument to a known reference value. For example, calibrate a digital multimeter against a known reference resistor to ensure its resistance measurement accuracy is traceable to the standard.
- **Relative calibration** is a process where you compare instrument values to another instrument that is already calibrated. Example Calibrate a temperature sensor by comparing its output to a reference thermometer, applying an offset or scaling factor to align the sensor's readings with the trusted reference.

Types of Equipment Calibration

1. Electrical Calibration

When we talk about electrical calibration, we're talking about making sure any device used to measure electricity is giving accurate readings. This includes things like voltage, current, and how fast electricity flows.

To do this, you use special tools to check if the devices are working correctly. A fancy digital meter can do a lot of these checks.

2. Mechanical Calibration

Mechanical calibration is about making sure devices that measure things like pressure, weight, size, and how things move are working right.

Over time, these devices can start giving wrong readings because of use, stress, or changes in temperature. To fix them, we use controlled temperature settings and special methods to make sure they're accurate.

3. Temperature Calibration

Temperature calibration is super important wherever temperature measurements really matter. It's done in a special room where everything is controlled. There are specialized thermometers, both electrical and mechanical, that help with this. Some tools that need regular calibration include:

- Systems that collect temperature data
- Thermometers with dials
- Devices that measure temperature from a distance
- Sensors used for precise temperature measurement
- Cameras that capture thermal images
- Devices that measure temperature directly or using wires
- Stations that record weather conditions

Practical Activity 1.4.2: Applying equipment Calibration procedures

Task:

1. Referring to **key reading 1.4.1 and 1.4.2,** you are requested to Read the given task. The task should be done **individually.**

Apply calibration procedures on multimeters, voltmeters, power supplies, and soldering stations that will be used in the assembly process.

2. List out procedures followed to perform the given task
3. Referring to procedures provided above, Perform the required task
4. Present your work to the whole class

Key readings 1.4.2: Applying equipment Calibration procedures

Steps for Performing Calibration of Multimeters, Voltmeters, Power Supplies, and Soldering Stations

1. **Prepare for Calibration**

o Gather the necessary calibration tools and reference standards, such as certified multimeters, voltage sources, and temperature gauges.

o Ensure all tools to be calibrated (multimeters, voltmeters, power supplies, soldering stations) are clean and free of visible damage.

o Isolate the tools from any ongoing assembly work and disconnect them from power sources or circuits.

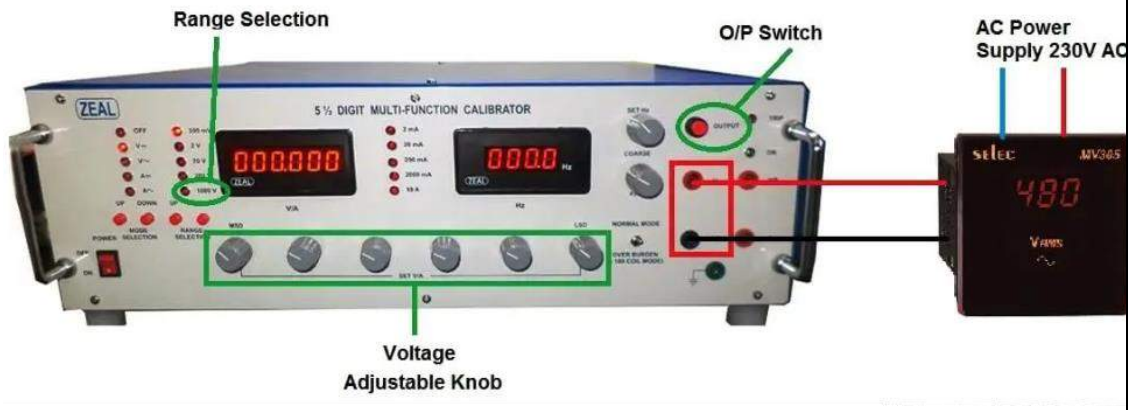
2. **Calibrate Multimeters**

o Connect the multimeter to a known and certified voltage/current source.

o Measure and compare the multimeters readings to the reference standard.

o If deviations are found, adjust the multimeter following the manufacturer's guidelines.

3. **Calibrate Voltmeters**



o Connect the voltmeter to a precise reference voltage source.

o Compare the voltmeter's readings with the reference voltage.

o Adjust the voltmeter if necessary and confirm the accuracy after adjustment.

4. **Calibrate Power Supplies**

- o Set the power supply to a known voltage and current output.
- o Use a calibrated multimeter or reference meter to measure the output.
- o Compare the actual output to the power supply's displayed value.

If necessary, adjust the power supply output to match the reference standard.

5. **Calibrate Soldering Stations**

- Set the soldering station to a specific temperature.
- Use a calibrated thermometer or temperature probe to measure the actual tip temperature.
- Compare the temperature reading with the set value on the soldering station.
- Adjust the station's temperature control if there are discrepancies.

6. **Finalize Task**

Ensure all equipment is properly powered off, and return tools to their designated locations.

Points to Remember

Description of Equipment Calibration

Types of Equipment Calibration

1. Temperature Calibration
2. Electrical Calibration
3. Mechanical Calibration

Equipment calibration is the process of checking and adjusting the accuracy of an instrument by comparing its readings with a standard reference.

Steps followed to calibrate equipment (example Multimeters, Voltmeters, Power Supplies, and Soldering Stations)

1. Prepare for Calibration
2. Calibrate Multimeters
3. Calibrate Voltmeters
4. Calibrate Power Supplies
5. Calibrate Soldering Stations

Application of learning 1.4

Company DIO is a sales organization that specializes in electronic devices. You have been hired as a computer system assembly technician to calibrate various equipment, including multimeters, power supplies, torque wrenches, and soldering stations to ensure the production of accurate and high-quality devices for sale

Learning outcome1 end assessment

Written assessment

1. **Answer by True for correct statement or False the wrong statements**
   i. Soldering is a method of joining two or more electronic components together using a filler metal.
   ii. A computer is a device that can perform calculations and process data automatically.
   iii. A properly working environment has no impact on productivity.
   iv. Hazard Control Measures are only necessary in industrial settings.
   v. Personal Protective Equipment (PPE) is not necessary when working with computers and PCBs.
   vi. Equipment calibration ensures the accuracy of measurement tools.

2. **Multiple Choice: choose the letter corresponding to the correct answer**

i.Which of the following is NOT a component of a computer system?

A) Monitor
B) Keyboard
C) Printer
D) Cloud Storage

ii.Computer hardware refers to:

A) Software applications
B) Physical components of a computer
C) User data
D) Internet connection

iii.Which of the following is NOT a characteristic of a good working environment?

A) Safety
B) Cleanliness
C) Noise
D) Comfort

iv.Which of the following is an ESD tool used in computer assembly?

A) Screwdriver
B) wrist strap
C) Multimeter
D) Soldering iron

v.Which type of calibration involves checking a tool against a known standard?

A) Primary Calibration
B) Secondary Calibration
C) Tertiary Calibration
D) None of the above

3. Match the items in Column A with the appropriate descriptions in Column B.

Column A	**Column B**
1.Hardware Components	Physical Hazards
2.Classifications of Hazards	CPU, RAM, GPU, Storage Devices, Power Supply Unit
3.Criteria for Selecting Tools and Equipment	Safety and Compliance, Functionality and Suitability, Cost-Effectiveness

Practical assessment

Company BSKY is a sales organization that specializes in assembling and retailing electronic devices. You are hired as a computer system assembly technician to prepare working environment for computer assembly, select tool, material and equipment needed thereafter calibrate various equipment that will be used including multimeters, power supplies, Voltmeter, and soldering stations. This task must be completed within one hour.

Reference

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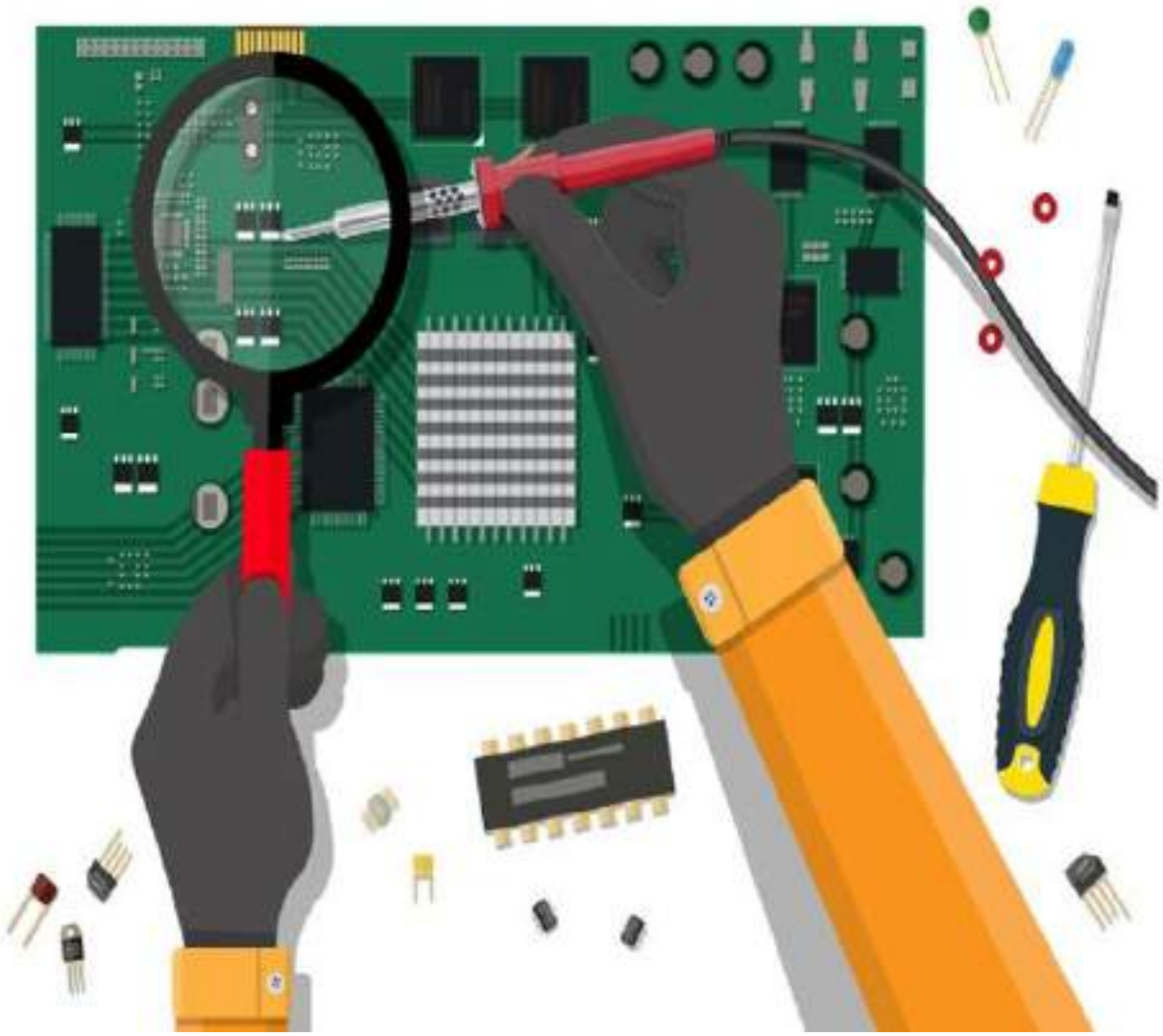


Indicative contents
2.1 Introduction to PCB **2.2 Identification of PCBA technologies** **2.3 Description of Surface Mount technology for PCBA** **2.4 Perform SMT PCB Assembly process**

Key Competencies for Learning Outcome 2: Assemble PCBA using SMT

Knowledge	Skills	Attitudes
• Description of PCBs • Identification of PCBA technologies. • Description of surface mount technology for PCBA • Description of the process involved in SMT PCB assembly	• Selecting PCBA technology • Applying SMT technology for PCBA • Perform SMT PCB Assembly process	• Being meticulous and attentive. • Being open to exploring and adapting to new technologies • Having a proactive approach towards learning. • Being precise and quality focused. • Being Innovative • Being creative

Duration: 50 hrs

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Describe accurately the fundamental concepts of PCBs as used in PCB assembling process.
2. Differentiate properly types of Surface Mount Technology (SMT) components as used in PCB assembly.
3. Describe accurately the Surface Mount Technology (SMT) as used in PCBA
4. Perform correctly SMT PCB assembly as used in SMT PCB assembly.

Resources

Equipment	Tools	Materials
● SMT Line (SMT Loader, Solder Paste Mixer, Solder Paste ● Printing Machine, Solder Paste Inspection machine (SPI), ● Pick and Place Machine, Reflow Machine), Automatic ● Optical Inspection (AOI), X-Ray inspection machine, ESD ● Tester, PPEs, Soldering Station, wave soldering machine,	● Diagnostic tools, ● ESD tools	● SMD, ● PTH components, ● Solder Paste, ● deionized water, ● PCB, ● SMT adhesive, ● soldering flux, ● soldering wire

Indicative content 2.1: Introduction to PCB

Duration: 8 hrs

Theoretical Activity 2.1.1: Description of PCB elements and their types

Tasks:

1. You are requested to answer the following questions related to the PCB.

1. List and describe the key elements of a PCB, including their roles and functions.
2. Differentiate between single-sided and double-layer PCBs.
3. What are the primary differences between rigid PCBs and flexible PCBs, and in what types of applications would each be used?
4. Explain the benefits of using flex-rigid PCBs, and provide examples of applications where they are commonly employed.

2: Provide the answers for the asked questions and write them on papers.

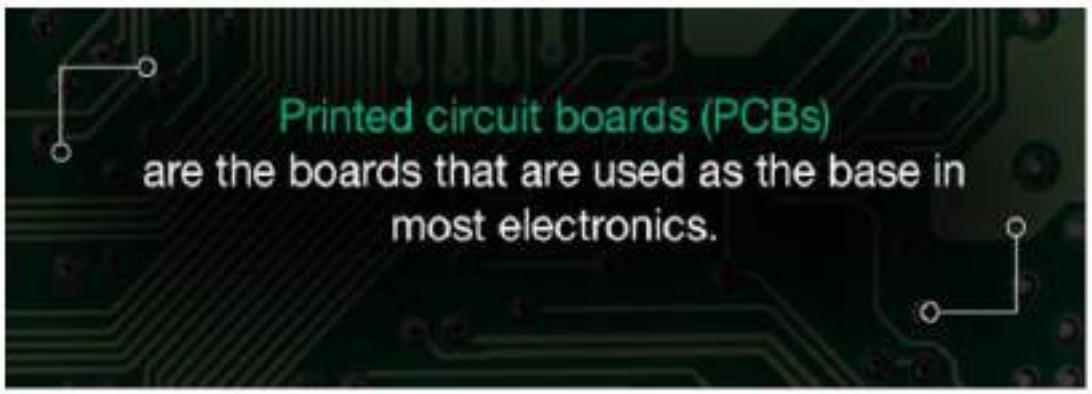
3: Present the findings/answers to the whole class.

4: For more clarification, read the **key readings 2.2.1.**

5: In addition, ask questions where necessary.

Key readings 2.1.1: Description of PCB elements and their types

1. PCB ELEMENTS



Key Components of a PCB:

- **Substrate:** The base material of the PCB, typically fiberglass or epoxy resin, providing mechanical support and electrical insulation.

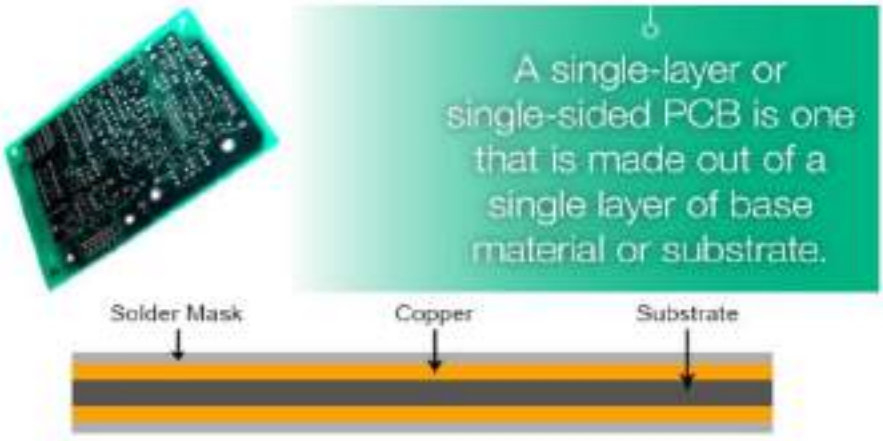
- **Copper Traces:** Conductive pathways etched onto the substrate, connecting different components and forming the electrical circuit.
- **Solder Mask:** A protective layer covering the copper traces, preventing accidental shorts and improving the board's appearance.
- **Component Pads:** Circular or rectangular areas on the PCB where components are soldered.
- **Visa:** Holes drilled through the PCB, allowing for vertical connections between different layers.
- **Silk Screen:** A layer printed on the PCB, providing component identification, markings, and design details.

2.1. Other Elements:

- **Resistors:** Components that resist the flow of electricity.
- **Capacitors:** Components that store electrical energy.
- **Inductors:** Components that resist changes in current flow.
- **Transistors:** Semiconductor devices that amplify or switch electronic signals.
- **Integrated Circuits (ICs):** Complex electronic circuits contained within a single package.
- **Connectors:** Components that allow for electrical connections between the PCB and other devices.
- **Switches:** Components that allow for the interruption or redirection of electrical current.

2. Types of PCB

➢ **Single-Sided PCBs**



Single-layer PCB Diagram

They are known as the simplest form of PCB. They have all the components and the copper traces are found on both sides of the board.

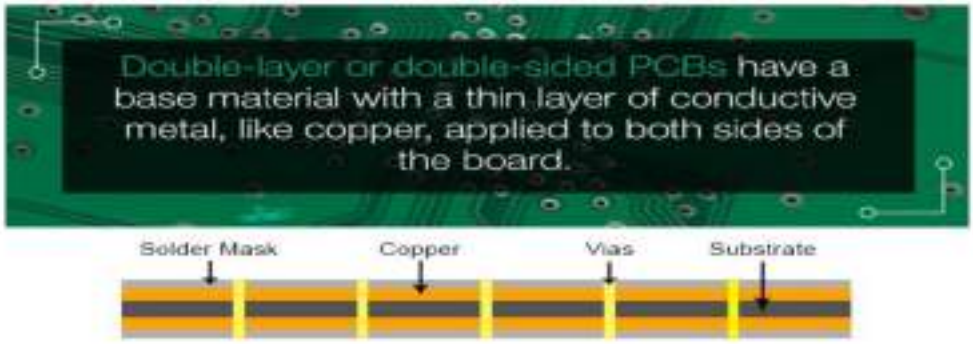
These kinds of PCBs are found in simple devices like

✓ LED lighting,

✓ calculators,

- ✓ etc.

➢ **Double-Layer PCBs**

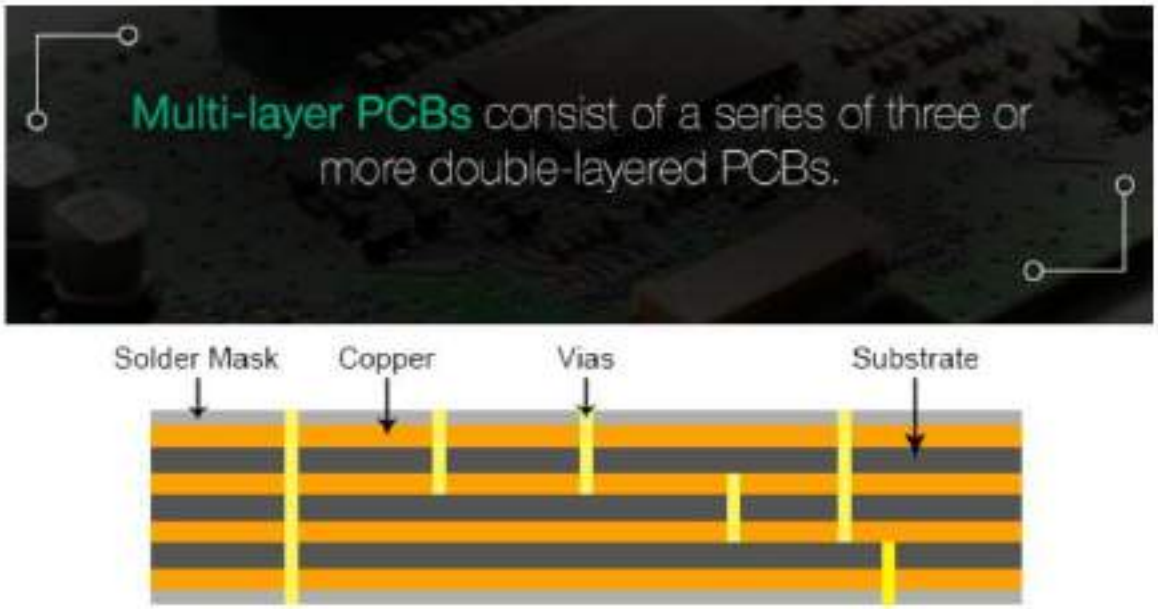


Double-layer PCB Diagram

These kinds of PCBs have copper traces and components on both sides of the board connected by via that pass through the board.

They are more complex and are found mostly in advanced electronic products like automobiles.

➢ **Multi-Layer PCBs**



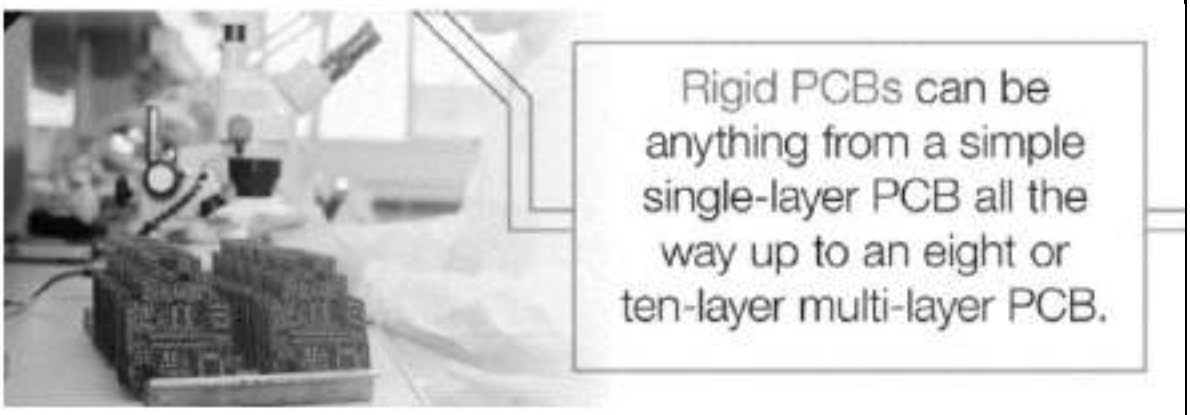
Multi-layer PCB Diagram

The PCBs of these kinds have multiple layers of conductive and insulating material allowing for more complex circuits with higher component density.

They are used in electronic devices like

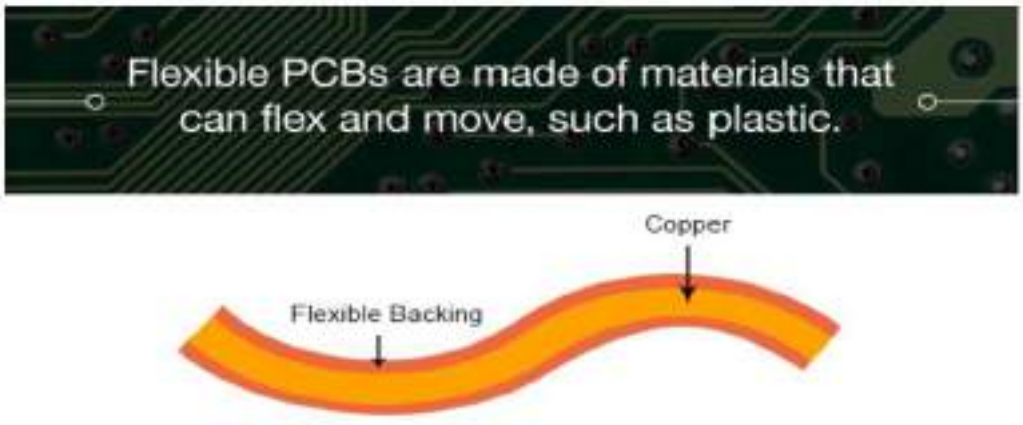
- ✓ computers,
- ✓ smartphones, and
- ✓ medical devices.

- **Rigid PCBs**



The rigid PCBs are made up of materials like fiberglass or epoxy. They are lightweight and can be used in high-end electronic applications. The purpose of using the rigid material is to make the board not flexible.

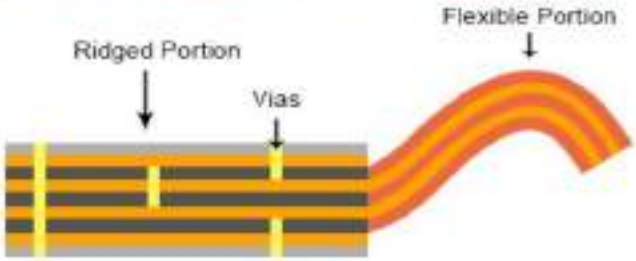
- **Flexible PCBs**



Flexible PCB Diagram

The PCBs of these kinds are made up of flexible materials like polyamide so that they can be bent or folded to fit into tight spaces. These are used in the applications where the space is limited, like medical devices and automotive electronics.

➢ **Flex-Rigid PCBs**



Flex-rigid PCB Diagram

The combination of rigid and flexible PCBs increases the utility of the application by allowing for advantages of both kinds. For example, aerospace applications and military electronics.

Points to Remember

Description of PCB elements and their types

PCB Elements:

- ✓ Substrate
- ✓ Copper Traces
- ✓ Solder Mask
- ✓ Component Pads
- ✓ Vias
- ✓ Silk Screen
- ✓ Resistors
- ✓ Capacitors
- ✓ Diodes
- ✓ Integrated Circuits (ICs)
- ✓ Connectors

- **Types of PCBs:**

  - ✓ **Single-Sided PCBs:** Simple boards with components and traces on one side.
  - ✓ **Double-Layer PCBs:** Boards with traces on both sides connected by vias.
  - ✓ **Multi-Layer PCBs:** Boards with multiple layers for complex circuits and higher density.
  - ✓ **Rigid PCBs:** Made from rigid materials, used in high-end applications.
  - ✓ **Flexible PCBs:** Made from flexible materials, used in tight spaces.
  - ✓ **Flex-Rigid PCBs:** Combination of rigid and flexible layers, used in aerospace and military applications.

Application of learning 2.1

You are part of a design team tasked with developing an electronic device. Each type of PCB has unique characteristics, advantages, and ideal applications. Your goal is to analyse the requirements of your project and recommend the best type of PCB.

Indicative content 2.2: Identification of PCBA Technologies

Duration: 12hrs

Theoretical Activity 2.2.1: Identification of PCBA technologies

Tasks:

1. you are requested to answer the following questions related to PCBA technologies
   i. What are the differences between Surface Mount Technology (SMT) and Through Hole Technology (THT)?
   ii. List 4 key points to put into considerations when choosing between SMT, THT, and Mixed Technology for a specific PCBA design?
   iii. Describe benefits of combining Surface Mount Technology (SMT) and Through Hole Technology (THT)?
   iv. What are the specific applications where Through Hole Technology (THT) is still preferred over SMT?
2. Present the findings to the whole class.
3. In addition, ask questions where necessary.
4. For more clarification, read the **key readings 2.2.1**

Key readings 2.2.1: Identification of PCBA technologies

1.SURFACE MOUNT TECHNOLOGY (SMT)

Surface Mount Technology (SMT) is a method where electronic components are mounted directly onto the surface of printed circuit boards. This technology has gained significant popularity due to its numerous advantages over traditional methods.

Key Features:

- **Component Design**: SMT components are typically smaller than their through-hole counterparts. They come in various packages such as chip resistors, capacitors, and integrated circuits.
- **Placement Process**: Components are placed on the PCB using automated pick-and-place machines that can accurately position thousands of components per hour.
- **Soldering Techniques**: The soldering process often involves reflow soldering, where solder paste is applied to pads on the PCB, and then components are placed before heating to melt the solder.

Advantages:

- **Higher Component Density**: SMT allows for more components to be placed on a single board due to its compact design.
- **Reduced Size and Weight**: Smaller components lead to lighter and more compact assemblies, which is critical for portable devices.
- **Improved Performance**: Shorter electrical paths reduce inductance and resistance, enhancing performance at high frequencies.

Disadvantages:

- **Repair Difficulty**: SMT components can be harder to replace or repair due to their small size and placement density.
- **Thermal Management Issues**: The close proximity of components can lead to overheating if not managed properly.

Applications

SMT is widely used in consumer electronics, computers, mobile devices, automotive electronics, and aerospace applications.

2 THROUGH-HOLE TECHNOLOGY (THT)

Definition:

Through-hole technology (THT) is a traditional method of assembling electronic components by inserting their leads through holes in the PCB and soldering them to the pads on the other side.

Advantages:

- **Lower initial investment:** THT equipment is less expensive than SMT equipment.
- **Simpler assembly process:** THT assembly is relatively straightforward and can be done manually.
- **Suitable for large components:** THT is suitable for components with large leads and high power requirements.

Disadvantages:

- **Lower component density:** THT leads to larger and less compact devices due to the larger component size and spacing.
- **Slower signal transmission:** Through-hole components have higher inductance and capacitance, leading to slower signal transmission.
- **Lower reliability:** THT connections are less reliable than SMT connections due to the larger solder joints and the potential for mechanical stress.

Applications:

THT is still used in some applications where component size and cost are critical factors, such as

- ✓ power supplies,
- ✓ transformers, and
- ✓ High-power devices.

3. MIXED TECHNOLOGY

Mixed Technology, as the name suggests, **combines both Surface Mount Technology and Through Hole Technology on a single printed circuit board.** This approach leverages the strengths of both methods while mitigating some weaknesses.

Key Features:

Hybrid Designs: Mixed technology allows designers to utilize both SMT for high-density areas while employing THT for components requiring additional mechanical strength or heat dissipation.

Advantages:

- **Flexibility in Design**: Designers can choose optimal mounting techniques based on specific component requirements and overall design goals.
- **Enhanced Functionality**: By integrating both technologies, mixed technology PCBs can accommodate a wider range of functionalities within limited space constraints.

Disadvantages:

- **Complex Manufacturing Process**: The integration of two different assembly techniques increases complexity in manufacturing processes and may require specialized equipment.
- **Cost Considerations**: Mixed technology assemblies may incur higher costs due to varied assembly processes and potential need for additional testing procedures.

Applications:

Mixed technology is commonly used in applications where both high component density and high power requirements are necessary, such as

- ✓ industrial control systems,
- ✓ medical devices, and
- ✓ automotive electronics.

Practical Activity 2.2.2: Selection of PCBA Technology

Task:

1. Referring to **key reading 2.2.2** you are requested to read the given task. The task should be done **individually.**

You are tasked with evaluating different PCBA technologies and choose the most suitable one for any electronic device.

2. List out procedures followed to perform the given task

3. Referring to procedures provided above, Perform the required task

Key readings 2.2.2: Selecting PCBA Technology

1. Define Product Requirements

The first and most crucial step in selecting a PCBA (Printed Circuit Board Assembly) technology is to clearly define the product's requirements. This includes:

- Functional Requirements: Determine what the product needs to do, such as signal integrity, power delivery, and environmental robustness.
- Mechanical Requirements: Evaluate the physical dimensions, weight, and design constraints.
- Environmental Considerations: Consider factors like operating temperature, humidity, vibration, and chemical exposure.
- Cost Constraints: Define the budget for the production of the PCBA, including development, manufacturing, and long-term maintenance.
- Compliance Requirements: Ensure that the assembly meets industry standards like IPC (Institute for Printed Circuits), CE, RoHS, and any regional compliance regulations.

2. Understand PCBA Technologies

Once the product requirements are established, it's essential to have a deep understanding of the available PCBA technologies:

- Through-Hole Technology (THT): Components are inserted into holes drilled in the PCB and soldered on the opposite side. Suitable for high mechanical stress environments but typically bulkier and more expensive.
- Surface-Mount Technology (SMT): Components are directly mounted on the surface of the PCB without drilling holes. SMT allows for higher component density, smaller boards, and is widely used in modern electronics.
- Mixed Technology: In some cases, a combination of THT and SMT is used, especially in complex designs where different strengths are required.
- Flex and Rigid-Flex PCBs: These are used when space constraints or flexible designs are needed. Flex boards are more expensive but offer significant advantages in specific use cases.

3. Evaluate Criteria Against Technologies

Once the options are understood, evaluate each PCBA technology against the defined product requirements:

- Component Density: SMT allows for smaller, denser components, making it ideal for compact designs.
- Mechanical Strength: THT provides better mechanical support for components like connectors and large capacitors.
- Cost Efficiency: SMT typically offers lower production costs in high-volume manufacturing. For low-volume or prototype manufacturing, THT may still be preferred.
- Reliability: SMT provides better electrical performance at higher frequencies, while THT is favored for components exposed to more mechanical stress.
- Thermal Management: Consider heat dissipation. SMT components typically require additional heat management systems, while THT can tolerate more heat.
- Test and Repair: THT technology tends to be easier to repair and inspect visually, while SMT often requires automated testing.

4. Analyse Trade-offs

Trade-offs often emerge when balancing different PCBA technologies against product requirements:

- Cost vs. Performance: While SMT might provide higher component density and performance, it may require a more expensive automated assembly line.
- Space Constraints vs. Mechanical Strength: Flex and SMT technologies save space but may lack the mechanical robustness of THT for some applications.
- Production Volume: Higher-volume manufacturing may favor SMT for cost and speed, while lower volumes may benefit from THT's simpler assembly process.

Analysing these trade-offs will help in deciding which technology best meets the design's goals within its constraints.

Points to Remember

Steps for Selecting PCBA Technology

1. Define Product Requirements
2. Understand PCBA Technologies
3. Evaluate Criteria Against Technologies

4. Analyse Trade-offs

Application of learning 2.2

Company Y is developing a new industrial control system that demands a reliable and efficient PCB assembly. Your task is to evaluate different PCBA technologies—Surface Mount Technology (SMT), Through Hole Technology (THT), and Mixed Technology—and choose the most suitable one for assembling a PCB prototype that meets the project's performance and reliability requirements.

Indicative content 2.3: Description of Surface Mount Technology for PCBA

Duration: 15 hrs

Theoretical Activity 2.3.1: Description of Surface Mount technology for PCBA

Tasks:

1. you are requested to answer the following questions related to **Surface Mount technology for PCBA**
   i. What are the main advantages of Surface Mount Technology (SMT) compared to traditional through-hole mounting techniques?
   ii. a) Describe the types of SMT components
   b) Provide 4 examples for each?
   iii. What are the advantages of using Ball Grid Arrays (BGAs) in SMT?
   iv. Why are ceramic packages preferred over plastic packages in certain SMT applications?
   v. a) Explain the different types of Surface Mount Technologies
   b) List production environments they are best suited for.
2. Present the findings/answers to the trainer.
3. For more clarification, read the **key readings 2.3.1**
4. In addition, ask questions where necessary.

Key readings 2.3.1: Description of Surface Mount technology for PCBA

Surface Mount Technology (SMT) is a method used in the manufacturing of electronic circuits where components are mounted directly onto the surface of printed circuit boards (PCBs). This technology has revolutionized electronics assembly by allowing for smaller, lighter, and more efficient designs compared to traditional through-hole mounting techniques.

SMT enables higher component density, improved performance, and reduced production costs.

Types of SMT Components

SMT components can be broadly categorized into two main types: passive and active components. Each type has distinct characteristics that influence their application in electronic circuits.

1.SURFACE MOUNT COMPONENT CHARACTERISTICS

✓ **Size and Form Factor:** SMT components are generally smaller than their through-hole counterparts, which allows for more compact PCB designs.

✓ **Electrical Performance:** Due to shorter lead lengths and lower parasitic inductance and capacitance, SMT components often exhibit better electrical performance.

✓ **Automated Assembly:** SMT is compatible with automated assembly processes, which enhances production efficiency.

✓ **Thermal Management:** Many SMT components have better thermal dissipation properties due to their flat package design.

2.PASSIVE SURFACE MOUNT COMPONENTS

Passive components are these components which do not require an external power source to operate. They include:

✓ **Resistors:** Used to limit current flow or divide voltages.

✓ **Capacitors:** Store electrical energy temporarily; they come in various types like ceramic, tantalum, and electrolytic.

✓ **Inductors:** Store energy in a magnetic field when electrical current passes through them.

✓ **Filters:** Passive filters can also be implemented using combinations of resistors, capacitors, and inductors.

These components are essential for controlling voltage levels and filtering signals within electronic circuits.

3.ACTIVE COMPONENTS: CERAMIC AND PLASTIC PACKAGES

Unlike passive components, Active components require an external power source to function.

They include:

✓ **Integrated Circuits (ICs):** These can be found in both ceramic and plastic packages. ICs perform various functions such as amplification, signal processing, or data storage.

✓ **Ceramic Packages:** Known for their excellent thermal stability and reliability; often used in high-performance applications.

✓ **Plastic Packages:** More cost-effective than ceramic packages but may have limitations regarding heat resistance and moisture sensitivity.

4.BALL GRID ARRAYS (BGAS)

BGAs are a type of surface mount packaging that uses an array of solder balls on the underside of the package instead of leads.

This design offers several advantages:

✓ Improved electrical performance due to shorter connections between the chip and PCB.

✓ Better thermal management because heat can dissipate evenly across the board.

✓ Higher pin count capabilities without increasing package size.

BGAs are widely used in high-density applications such as microprocessors and memory chips.

Types of Surface Mounting Technologies

Surface mount technologies can be classified into three main types based on their assembly processes:

Type I SMT

Type I SMT involves basic surface mount techniques that utilize manual or semi-automated processes for placing components on PCBs. This method is typically employed for low-volume production runs or prototyping where flexibility is needed over speed.

Type II SMT

Type II SMT represents a middle ground between Type I and Type III technologies. It employs automated pick-and-place machines but may still involve some manual intervention during assembly. This approach balances efficiency with adaptability, making it suitable for medium-volume production environments.

Type III SMT

Type III SMT refers to the use of advanced automated placement equipment capable of handling complex component shapes and sizes. This technology is suitable for high-volume production where speed and precision are critical. Type III assemblies often incorporate features like vision systems for alignment verification during placement.

Practical Activity 2.3.2: Selecting of Types of Surface Mounting technologies to use

Task:

1. Referring to **key reading 2.3.2,** you are requested to do the given task. The task should be done **individually.**

You are tasked with selecting suitable Surface Mount Technology (SMT) to assemble the components on the printed circuit board (PCB).

2. List out procedures followed to perform the given task

3. Referring to procedures provided above, Perform the required task

4. Present your work to the trainer.

Key readings 2.3.2: Selection for surface mounting technologies types

1. Production Volume

Production volume refers to the number of units you intend to manufacture, and it plays a significant role in determining the appropriate SMT type for your project.

- **High-Volume Production:** If you are manufacturing in large quantities, automated SMT assembly is the most efficient and cost-effective option. Automated pick-and-place machines can place thousands of components per hour, greatly reducing production time and labor costs. This approach typically justifies the upfront costs of setting up the assembly line, as economies of scale reduce the per-unit cost with higher production volumes.

- **Low-Volume or Prototype Production:** For small-batch or prototype production, the benefits of automation might not outweigh the setup costs. In this case, manual or semi-automated SMT assembly might be preferred. These approaches are slower but more cost-effective for low volumes. You might also need more flexibility in terms of component changes or adjustments during the production process, which is easier in manual or small-batch assembly.

- **Mid-Volume Production:** For medium-volume production, manufacturers often balance between manual and automated processes. Some components may be placed manually, while others are placed using machines. Selecting the right level of automation is crucial to optimize production efficiency while keeping costs in check.

2. Cost

Cost is always a critical factor in selecting an SMT type, as it affects the overall manufacturing budget.

- **Capital Investment:** Automated SMT assembly lines involve significant capital investment in pick-and-place machines, reflow ovens, and solder paste printers. For high-volume production, this cost is offset by the reduced labor and faster production times. However, for small batches or prototypes, this level of investment may not be justified.

- **Labor Costs**: Manual SMT assembly requires skilled labor to place components accurately. This approach increases labor costs but avoids the need for expensive machinery. For low production volumes or highly customized projects, manual assembly can sometimes be more economical despite higher labor costs.

- **Component Costs**: The type of SMT components also impacts cost. High-density or highly integrated components, such as ball grid arrays (BGAs) or chip-scale packages (CSPs), may be more expensive but offer significant performance benefits. Ensuring the balance between component costs and the budget is essential for optimizing total cost.

- **Yield and Rework Costs:** SMT technology can result in varying defect rates depending on the type of assembly used. More sophisticated components and higher levels of automation often result in lower defect rates, reducing the need for rework. However, lower-cost manual methods might have a higher defect rate, increasing the cost of rework and quality control.

3. Component Complexity

Component complexity refers to the intricacy of the electronic components used in the assembly, such as their size, shape, lead configuration, and pin count.

- **Simple Components:** Components like resistors, capacitors, and simple ICs are relatively easy to place and solder, even with manual or semi-automated processes. They are compatible with most SMT methods, and the choice between manual or automated assembly depends on production volume rather than complexity.

- **Complex Components:** Components like BGAs, microcontrollers, and high-pin-count ICs are more challenging to place and solder. Automated assembly is usually necessary for these components because they require precise placement and soldering to ensure proper functionality. Additionally, complex components might need advanced inspection techniques, such as X-ray inspection for BGAs, to ensure there are no hidden defects like solder bridging or open connections.

- **Miniaturization:** With advancements in technology, component sizes have significantly reduced. SMT types that can handle ultra-miniature components are crucial for industries like consumer electronics, where compact designs are necessary. Automated SMT is the best solution for handling such small, intricate parts, as manual handling can increase the risk of misplacement or damage.

4. Flexibility Requirements

Flexibility refers to the ability of the SMT process to adapt to changes in design, component choice, or production needs.

- **Prototyping and R&D:** In the early stages of product development or prototyping, flexibility is key. The ability to quickly change components or modify the PCB layout without significant delays is important. For these cases, manual

SMT or a highly adaptable semi-automated process might be ideal, as it allows for rapid adjustments. Automated systems can be less flexible due to the time required to change machine setups or reprogram pick-and-place machines.

- **Customization:** Some products may require a high degree of customization, where different batches have different configurations of components or designs. In such cases, flexible SMT systems that allow for quick setup changes or manual intervention may be needed. Manual SMT offers more flexibility for small, customized batches.

- **High-Mix, Low-Volume (HMLV) Manufacturing:** For manufacturers producing a wide range of products in small quantities, SMT systems must be flexible enough to handle different types of components and PCBs with minimal downtime. This often requires more manual intervention or modular machine setups that allow quick changes.

5. Quality Control

Quality control is a crucial factor in determining the type of SMT process to ensure that the final product meets design and functional specifications.

- **Automated Inspection Systems (AOI):** In high-volume, automated SMT assembly, quality control is usually managed with Automated Optical Inspection (AOI) systems that check the placement of components and the quality of solder joints. These systems are highly efficient and reduce human error, ensuring consistent quality across large production runs.

- **Manual Inspection:** In smaller production volumes or more complex assemblies, manual inspection might be required, especially when dealing with unique or intricate components. However, manual inspection is more time-consuming and prone to errors, so it is less suited for high-volume production.

- **Defect Rates:** Automated systems tend to have lower defect rates due to the precision of the machines and consistent handling of components. However, even automated SMT processes require careful calibration and monitoring to maintain high-quality output.

- **Rework and Repair:** In some cases, the SMT type selected should also consider the ease of reworking or repairing defective PCBs. Some automated processes, such as soldering of fine-pitch components or BGAs, are difficult to rework manually. Hence, a more careful quality control process is required upfront to minimize defects that need rework.

- **Testing Protocols:** In complex assemblies, quality control may involve in-circuit testing (ICT) or functional testing of the assembled PCB. Ensuring that the SMT

type chosen supports these testing protocols is critical to maintaining the product's reliability. Certain types of components and assembly processes lend themselves better to specific testing methodologies.

Points to Remember

Surface mount technology for PCBA

SMT mounts components directly onto the surface of PCBs, enabling smaller, lighter, and more efficient designs compared to through-hole techniques.

Component Types:

Passive Components: Passive components are those that do not require any external power to operate, and they cannot amplify or increase the power of a signal. They typically store, dissipate, or release energy in some form.

Examples: Resistors, capacitors, inductors.

Active Components:

Active components: are those that require an external power source to function, and they can control the flow of current. They are capable of amplifying signals or generating power.

Examples: Transistors, diodes, operational amplifiers, vacuum tubes.

Ball Grid Arrays (BGAs):

Use solder balls for connections, offering improved electrical performance, better thermal management, and higher pin count capabilities.

Types of SMT:

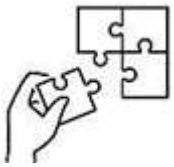
Type I SMT: Type I SMT involves basic surface mount techniques that utilize manual or semi-automated processes for placing components on PCBs.

Type II SMT: Type II is a hybrid assembly with surface-mount components on one side of the PCB and through-hole components on the other side.

Type III SMT: Type III is a mixed-technology assembly where through-hole components are placed on both sides of the PCB, while SMT components are only on one side.

Factors to consider when selecting for surface mounting technologies types

- ✓ Production Volume
- ✓ Cost
- ✓ Component complexity
- ✓ Flexibility requirements
- ✓ Quality control



Application of learning 2.3

You are an electronics engineer working for a company that manufactures advanced communication devices. Your team has just been assigned a new project to develop a compact and high-performance communication module for 5G networks. This device needs to be lightweight, reliable, and capable of functioning under extreme environmental conditions. You are tasked with selecting the most suitable Surface Mount Technology (SMT) for assembling the components on the printed circuit board (PCB) of this module.

Indicative content 2.4 : Perform SMT PCB Assembly Process

Duration: 15 hrs

Practical Activity 2.4.2: Assembling PCB using SMT

Task:

1. Referring to **key reading 2.4.2,** you are requested to complete the given task. The task should be done **individually.**

You're tasked with performing SMT PCB assembly for an electronic device.

2. List out procedures followed to perform the given task

3. Referring to procedures provided above, Perform the required task

4. Present your work to the trainer.

Key readings 2.4.2: SMT PCB Assembly process

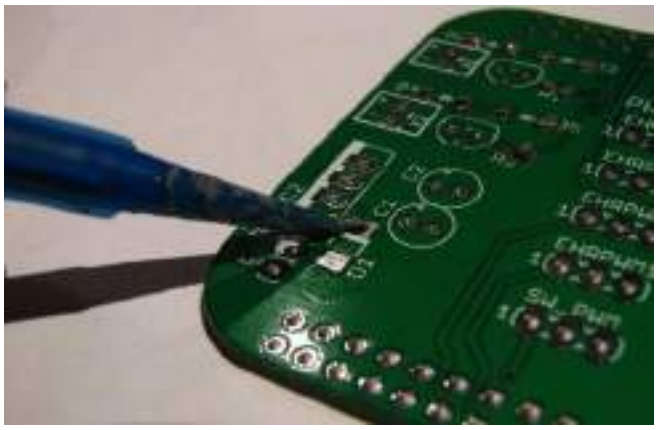
Steps Involved in SMT PCB Assembly Process

1.Load PCB into assembling machine

Loading a Printed Circuit Board (PCB) into an assembling machine is a crucial step in the Surface Mount Technology (SMT) process. It involves preparing the PCB,

aligning it correctly within the machine, and ensuring it's positioned for precise component placement.

1. Solder Paste Application



o Prepare a stencil based on PCB design.

o Apply solder paste using the stencil, ensuring precise alignment with PCB pads.

2. Component Placement

o Use a pick-and-place machine to accurately position components onto the solder paste-covered pads.

o For low-volume or prototypes, manually place components using tweezers.

3. Reflow Soldering

o Pass the PCB with components through a reflow oven.

o Control the temperature profile to melt the solder paste and create solid solder joints without damaging components.

4. Inspection and Testing

- Conduct a visual inspection to check for solder bridges, missing components, and other visible defects.
- Use Automated Optical Inspection (AOI) to verify the quality of solder joints and component placement.
- Perform functional testing to ensure the PCB operates as intended.

Once the PCBA (Printed Circuit Board Assembly) is completed, it undergoes several testing phases to ensure proper functionality:

Electrical Testing:

Continuity: Ensures that electrical paths are complete and connected.

Shorts: Detects unwanted connections between different circuits.

Opens: Identifies any breaks or missing connections in the circuitry.

Functionality Test:

Verifies that the board powers up correctly.

Confirms that signals and data flow through the board as expected.

Visual Inspection:

Checks for misplaced, missing, or incorrectly oriented components.

Inspects for soldering defects, such as cold solder joints or bridges between pins.

5. Post-Assembly Processes

- Clean the PCB to remove any flux residues if required.
- Address any defects identified during inspection or testing through repair and rework.

Points to Remember

Steps involved in SMT PCB Assembly process:

1. Load PCB into assembling machine
2. Solder Paste Application
3. Component Placement
4. Reflow Soldering
5. Inspection and Testing
6. Post-Assembly

Application of learning 2.4

You are a newly hired technician at a leading electronics manufacturing company. Your task is to assemble a PCBA for a critical project using Surface Mount Technology (SMT). The assembly process is crucial as it directly impacts the functionality and reliability of the final product. You will need to follow specific instructions to ensure the PCBA is correctly assembled.

Learning outcome 2 end assessment

Written assessment

1. Multiple Choice Questions (MCQs)

I. Which of the following is NOT an element of a PCB?
   a) Copper Traces
   b) Solder Mask
   c) Ground Plane
   d) Resistor

II. Which type of SMT component package typically includes solder balls and is used for high-density interconnections?
   a) SOT-23
   b) QFP
   c) BGA
   d) DIP

III. Passive surface mount components include:
   a) Resistors, Capacitors, and Inductors
   b) Microcontrollers, Diodes, and LEDs
   c) Transistors, Relays, and ICs
   d) Crystals, Oscillators, and Sensors

IV. Type II SMT technology is characterized by:
   a) Components on only one side of the PCB
   b) Components on both sides of the PCB
   c) Mixed through-hole and surface mount components
   d) Only passive components mounted on the PCB

V. What is the primary advantage of using Surface Mount Technology (SMT) over Through-Hole Technology?
   a) Easier for manual assembly
   b) Reduced size and weight of the PCB
   c) Higher power handling capacity
   d) Better mechanical strength
   e) 2 . Matching Questions

Match the terms in Column A with the correct descriptions in Column B:

Column A	**Column B**
1. PCB elements	A. Technology where components are mounted directly onto the surface of the PCB.
2.SurfaceMount Technology (SMT)	B. Tiny, passive electronic components like resistors and capacitors.
3. Through-Hole Technology (THT)	C. The components used to build a printed circuit board, such as pads, traces, and vias.

4. Mixed Technology	D. A method where component leads are inserted into drilled holes on the PCB.
5. Passive Surface Mount Components	E. Components such as transistors and integrated circuits (ICs), typically enclosed in ceramic or plastic packages.
6. Active Components: Ceramic and Plastic Packages	F. A combination of both Surface Mount and Through-Hole technologies in PCBA.
7. Ball Grid Arrays (BGAs)	G. A type of SMT component that uses an array of solder balls for electrical connections.
8. Type I SMT	H. An SMT assembly process where all components are placed on one side of the PCB.
9. Type II SMT	I. A process involving placing both SMT components on one side and through-hole components on the other side of the PCB.
10. Type III SMT	J. An assembly process involving components on both sides of the PCB.
11. Perform SMT PCB Assembly Process	K. The process of placing and soldering surface-mount components onto the PCB.
12. Surface Mount Component Characteristics	L. The distinct features and behaviors of components, such as size, weight, and electrical properties, that affect their mounting and performance.

3: Fill in the blanks

A. A Printed Circuit Board (PCB) is typically composed of layers, including _____, _____, and _____, which contribute to the board's functionality.
B. Surface Mount Technology (SMT) utilizes _____ components, which are directly mounted onto the PCB without the need for _____, as required in Through-Hole Technology.
C. Active SMT components are typically housed in _____ or _____ packages, which provide protection and facilitate automated assembly processes.
D. The _____ process in SMT assembly involves applying a layer of solder paste onto the PCB pads using a stencil, which is then used to mount components onto the board.
E. Ball Grid Arrays (BGAs) use _____ to connect the component to the PCB, providing a high-density interconnection that is especially useful in _____ applications.

Practical assessment

As a newly hired computer assembly technician at a XYZ electronics manufacturing firm, your responsibility is to assemble a Printed Circuit Board Assembly (PCBA) using Surface Mount Technology (SMT).

Your tasks include:

1. Preparing the PCB by applying solder paste to designated pads.

2. Accurately placing surface mount components onto the PCB.
3. Utilizing a reflow oven to solder components to the PCB.
4. Conducting inspections to verify the quality and performance of the assembled board.

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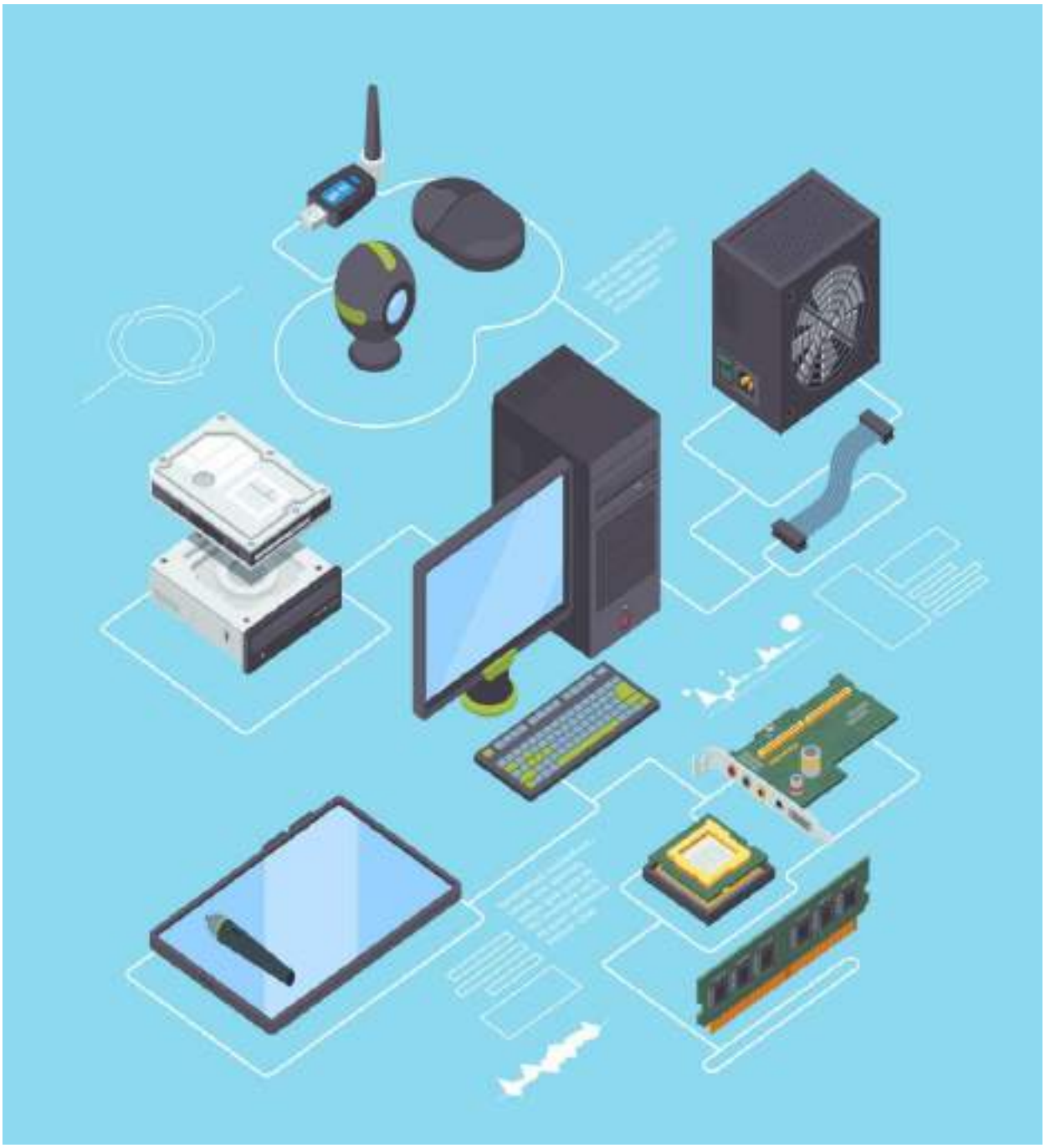


Indicative contents
3.1 Description of computer hardware parts **3.2 Connection of Desktop Computer parts** **3.3 Connection of Laptop Computer parts** **3.4 Test of assembled computer** **3.5 Documentation of Assembly report**

Key Competencies For Learning Outcome 3 : Connect Computer System Parts

Knowledge	Skills	Attitudes
● Description of Computer Hardware Parts ● Description of Desktop computer Parts ● Description of laptop computer Parts	● Connecting Desktop computer Parts ● Connecting Laptop computer Parts ● Testing assembled computer ● Documenting Assembly report	● Having Attention to detail ● Being Patience and perseverance ● Having Safety-consciousness ● Having Problem-solving mindset ● Being Openness to learning

Duration: 20 hrs

Learning outcome 3 Objectives

By the end of the learning outcome, the trainees will be able to:

1. Assemble properly Computer hardware parts based on Standard of Product.
2. Test successfully computer system according to the computer system functionality
3. Prepare properly assembling report according to the task under taken.

Resources

Equipment	Tools	Materials
● Digital Torque meter ● power supply tester ● ESD tester ● PPEs ●	● Anti-static wrist strap ● anti-static mat ● Screw Drivers ● Screw feeder ● ESD Tray	● monitor ● keyboard ● Computer case ● Power supply ● Motherboard ● CPU ● Heat sink/fan assembly ● Thermal compound ● RAM module(s) ● Motherboard standoffs and screws ● Adapter cards ● HDD, CD/DVD Drive, Floppy Drive ● SATA data cable, PATA data cable, Floppy Drive cable ● laptop battery

Indicative content 3.1 : Description of Computer Hardware Parts

Duration: 2 hrs

Theoretical Activity 3.1.1: Description computer hardware parts

Tasks:

1. you are requested to answer the following questions related to the Description of computer hardware parts
   i. Define the term computer Hardware
   ii. Differentiate input from output devices and outline 5 examples on each
   iii. Outline five (5) examples of storage Devices
   iv. What is the main importance of CPU
   v. List three (3) communication devices
   vi. Why do we need cables and Buses?
2. Provide the answers for the asked questions and write them on papers.
3. Present the findings to the whole class.
4. For more clarification, **read the key readings 3.1.1**
5. In addition, ask questions where necessary.

Key readings 3.1.1: Description computer hardware parts

Description of computer hardware parts

•Computer hardware refers to the physical parts of a computer and related devices. The internal hardware parts of a computer are often referred to as components and the external hardware devices are usually called peripherals.

•**Computer Hardware** includes the physical parts of a computer, such as the central processing unit (CPU), random access memory (RAM), motherboard, computer data storage, graphics card, sound card, and computer case. It includes external devices such as a monitor, mouse, keyboard, and speakers.

Types of hardware

They are different types of computer hardware found in a computer. These are:

1. Input
2. Output
3. Storage

4. Processing
5. Communication.

1. **An input devices**

Input device allows the user to interact directly with a computer. The devices give data and instructions to the computer, such as:

Keyboards: Devices with alphanumeric keys that allow users to enter text, commands, and other data into a computer or other electronic device.

Pointing Devices (Mouse): Hand-operated input devices that control the movement of a cursor or pointer on a display, allowing for precise selection and manipulation of on-screen elements.

Touchscreens: Display devices that can detect touch input, enabling users to interact with on-screen content directly with their fingers.

Touchpads: Touch-sensitive input surfaces, typically found on laptop computers that function as pointing devices.

Tablet/Pen Input Devices: Specialized input devices that allow users to write, draw, or interact with a computer using a digital pen or stylus.

Game Controllers: Input devices designed for interacting with video games, often including buttons, joysticks, triggers, and other controls.

Cameras: Devices that capture still images or video, which can be used as input for various applications.

Microphones: Audio input devices that convert sound waves into electrical signals, enabling speech recognition and audio recording.

Video Capture Devices: Hardware that digitizes and records video signals, often used for live streaming, video conferencing, or video editing.

Scanners: Devices that optically capture and convert printed or handwritten text, images, or objects into digital form.

Optical Readers: Input devices that can interpret and convert printed or encoded information, such as barcodes or QR codes, into digital data.

Biometric Devices: Input devices that use biological or behavioral characteristics, such as fingerprints, iris patterns, or voice recognition, to identify and authenticate users.

Data Collection Devices: Various input devices that gather and transmit data, such as sensors, GPS receivers, or RFID readers, for use in data-driven applications.

2. Output

- display or communicate the results of computer processing.
- a hardware component of a computer system that displays information to users.

Common output devices include:

a. Monitor/Display: Shows visual information such as text, graphics, and videos.

b. Printer: Produces physical copies of digital documents and images on paper.

c. Speakers: Convert digital audio signals into sound that can be heard.

d. Projector: Projects images or video onto a larger screen or surface.

3. Storage

- Storage devices are used to retain data and programs for future use.

Common storage devices include:

- Hard Disk Drive (HDD): Provides large-capacity, non-volatile storage for files, programs, and the operating system.

- Solid-State Drive (SSD): Offers faster data access and retrieval compared to HDDs, but with typically lower storage capacities.

- USB Flash Drive: Portable, removable storage devices that can be easily transported and shared.

- Optical Discs (CD, DVD, Blu-ray): Offer read-only, recordable, or rewritable storage for data, music, and video.

4. PROCESSING DEVICES

Processing devices are responsible for carrying out instructions and performing calculations.

The most important processing devices are:

- Central Processing Unit (CPU)
- Graphics Processing Unit (GPU).

4.1 CENTRAL PROCESSING UNIT (CPU)

The central processing unit (CPU) is located inside the computer case on the motherboard. It is the part of a computer responsible for receiving and carrying out computer instructions (processing).

Each CPU can be made up of multiple cores, which are independent processing units that can complete tasks on their own (multithreading vs multiprocessing). By adding multiple cores to a CPU, the processing power available to the computer can increase dramatically, with little heat gain. These types of processors are called multi-core processors.

The CPU contains a control unit (CU) that coordinates all activities in the CPU, and an arithmetic logic unit (ALU) where the logic operations and arithmetic calculations are carried out.

4.2 GRAPHICS PROCESSING UNIT (GPU)

The graphics processing unit (GPU) is located on plug-in cards on the motherboard or in the same chip as the CPU. It is responsible for creating and doing the calculations needed to display images on the screen.

Communication devises

- Communication devices enable a computer to exchange data with other devices or networks.

Common communication devices include:

- Network Interface Card (NIC): Allows a computer to connect to a local area network (LAN) or the internet.

- Wireless Adapter: Provides wireless connectivity, enabling a computer to connect to wireless networks and communicate without physical cables.

- **Modem:** Modulates and demodulates digital signals for transmission over analog telephone lines, enabling internet access.

Cables and Buses

- **Cables** are physical connections that transfer data, power, or both between computer components and peripheral devices.
- Examples: HDMI, USB, Ethernet, power cables, etc.

- **Buses** are communication systems that transfer data between the various components inside a computer.
- Examples: PCI, PCIe, SATA, USB, etc.

Points to Remember

Description of computer hardware parts

- **Computer Hardware** includes the physical parts of a computer, such as the central processing unit (CPU), random access memory (RAM), motherboard, computer data storage, graphics card, sound card, and computer case. It includes external devices such as a monitor, mouse, keyboard, and speakers.

Types of computer hardware

They have different types of computer hardware found in a computer. These are:

1. Input
2. Output
3. Storage
4. Processing
5. Communication devices

Application of learning 3.1

Company AKI is launching a computer assembly initiative and is seeking a computer system assembly technician to select essential hardware components for Their operations. You are hired and asked to Identify appropriate input components that enhance user interaction and output components that effectively convey information to users. And lastly Select reliable storage solutions to ensure optimal data management.

Indicative content 3.2: Connection of Desktop Computer Parts

Duration: 4 hrs

Theoretical Activity 3.2.1: Description Desktop Computer parts

Tasks: In small groups, you are requested to answer the following questions related to Description of Desktop Computer parts.

i. What role does the power supply play in a desktop computer system?
ii. Name the key connection points on a motherboard?
iii. What is the main role of adapter card in desktop computer?
iv. Write in full a) SSD b) HDD
v. How does the display connect to the graphics card or motherboard?

2: Provide the answers for the asked questions and write them on papers.

4. Present the findings to the whole class.

4: For more clarification, read the **key readings 3.2.1.**

5: In addition, ask questions where necessary.

Key readings 3.2.1: Description Desktop Computer parts

Description of a Desktop Computer parts

When assembling a desktop computer, the correct connection of its various components is essential for smooth operation.

Below are detailed notes on the primary parts involved in the process, including the power supply, motherboard, adapter cards, internal drives, external bays, internal cables, and display setup.

1. Power Supply

- **Positioning:** The power supply unit (PSU) is typically installed in the top or bottom rear of the case. It is secured with screws to the case's back panel.
- **Connection:**
  - o **24-pin ATX connector:** This provides power to the motherboard and is one of the main connectors.
  - o **4/8-pin CPU power connector:** Supplies power to the CPU. It connects near the top of the motherboard.
  - o **SATA/Molex cables:** These connect to storage drives (HDD, SSD), optical drives, or other peripherals that require power.
  - o **PCIe power connector:** This is used if you have a graphics card (GPU) that

2. Motherboard

- **Positioning:** The motherboard is placed on pre-installed standoffs in the case and screwed into position.
- **Connection:**
  - **CPU Socket:** Install the CPU and secure it with the socket latch. Ensure the correct orientation (look for the gold triangle).
  - **RAM Slots:** Insert RAM modules into the designated DIMM slots and ensure they click into place.
  - **Power Connection:** Attach the 24-pin ATX power cable from the PSU and the 8-pin (or 4-pin) CPU power cable.
  - **Front Panel Connections:** Connect power/reset switches, HDD LED, and case fans to the motherboard headers.
  - **SATA Ports:** Connect the SATA cables from internal storage drives to the motherboard.

Important Consideration: Ensure proper alignment and spacing when installing components like the CPU and RAM to avoid damaging the motherboard.

3. Adapter Cards (Expansion Cards)

- **Positioning:** Adapter cards like graphics cards, network cards, and sound cards are installed in the PCIe (Peripheral Component Interconnect Express) slots on the motherboard.
- **Connection:**
  - **PCIe Slot:** Insert the adapter card into the appropriate PCIe slot. For GPUs, use the x16 slot for maximum bandwidth.
  - **Power Connection:** If the GPU requires extra power, connect the PCIe power cables (6-pin or 8-pin) from the PSU.
  - **Screwing:** Secure the card to the case using screws to prevent movement.

4. Internal Drives

- **Positioning:**
  - **HDD/SSD:** Most modern desktops use 2.5" or 3.5" drives that are mounted inside drive bays.
  - **M.2 NVMe SSD:** Installed directly onto the motherboard in the M.2 slot if available.
- **Connection:**
  - **SATA Drives:** Connect both the SATA power cable from the PSU and the SATA data cable from the motherboard to the drive.
  - **M.2 Drives:** Insert the M.2 SSD into the M.2 slot and secure it with a small screw.

Important Consideration: Ensure that SSDs and HDDs are firmly mounted and that cables are connected properly for reliable operation.

5. Drives in External Bays

- **Positioning:**

- External drives like DVD/Blu-ray drives are installed in the 5.25" external bays located at the front of the case.

- **Connection:**
  - **Power Connection:** Use a SATA power cable from the PSU to supply power to the drive.
  - **Data Connection:** Connect the SATA data cable from the motherboard to the drive.

Important Consideration: Ensure the correct alignment of drives in external bays, as they should be accessible from the front of the case for easy use.

6. Internal Cables

- **Types:**
  - **Power Cables:** These include the 24-pin motherboard power connector, 8-pin CPU power connector, and SATA/Molex power cables for drives and other peripherals.
  - **Data Cables:** SATA data cables for connecting storage devices (HDD, SSD) to the motherboard.
  - **Fan Headers:** Connect the case and CPU fans to the motherboard's fan headers to enable control through the BIOS or software.
- **Cable Management:**
  - Tidy up excess cables using zip ties or Velcro straps to improve airflow and keep the case organized.
  - Route cables through the back of the case if possible to avoid obstructing airflow inside the case.

7. Display

- **Connection:**
  - **Video Output Ports:** Once the desktop is assembled, connect the monitor to the display output ports (HDMI, DisplayPort, VGA, or DVI) on the GPU or motherboard (if using integrated graphics).
  - **Power Connection:** Ensure the monitor is plugged into a power source.
  - **Adjust Display Settings:** Once the system is powered on, adjust the display resolution and refresh rate to match the monitor's specifications for the best viewing experience.

Final Steps:

- **BIOS Setup:** Once the system is assembled, power it on and enter the BIOS/UEFI to ensure all components are recognized. This is also where you can configure boot priorities for your storage devices.
- **Operating System Installation:** Install the OS on the main drive (usually SSD for speed) and configure system settings.

Practical Activity 3.2.2: Connecting Desktop Computer parts

Task:

1. Referring to **key reading 3.2.2,** you are requested to Read the given task. The task should be done **individually.**

   You are tasked with assembling all the components to create a fully functioning desktop computer.
2. List out procedures followed to perform the given task
3. Present your work to the whole class
4. Ask for clarification where necessary

Key readings 3.2.2: Connecting Desktop Computer parts

steps to connect desktop computer parts

Step 1: Remove Side Panels on Case

Remove the side panels of the desktop case to access the interior components.

Step 2: Insert Motherboard

- ✓ Align the motherboard with standoffs in the case.
- ✓ Secure with screws at designated holes.
- ✓ Connect the power supply cables and front panel connectors.

Step 3: Check Clearances

Check Clearances involves ensuring all components in the computer assembly fit properly without interference, confirming adequate space for airflow, and verifying that no parts are touching or obstructing each other.

Step 4: Front Panel Connections

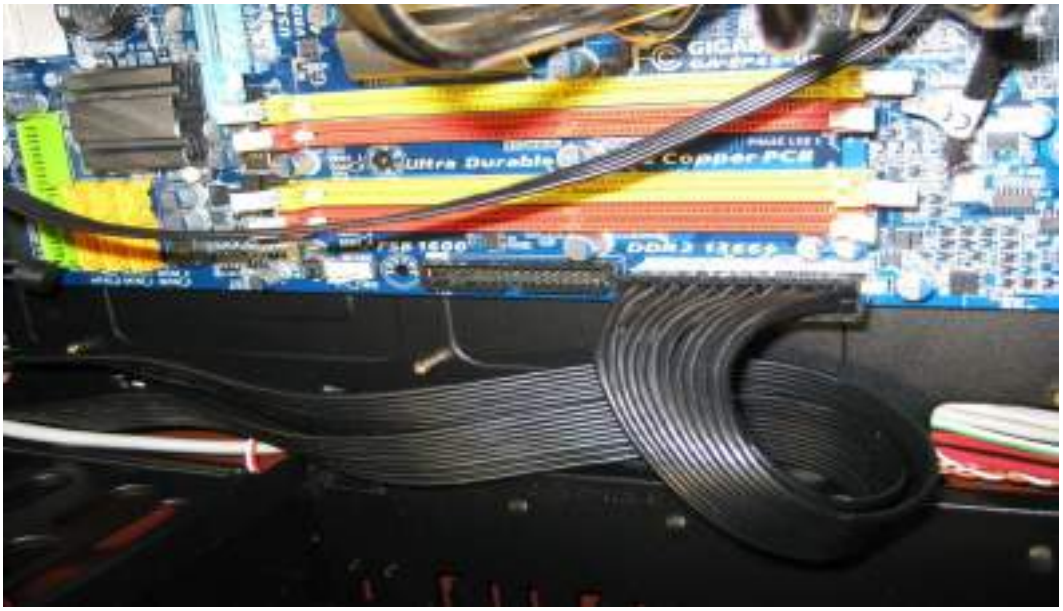
Front Panel Connections involves connecting the computer case's front panel cables (like power switch, reset switch, USB ports, and audio jacks) to the motherboard, ensuring proper functionality for user controls and ports.

Step 5: Install Power Supply

Install Power Supply involves securing the power supply unit (PSU) into the computer case, connecting it to the motherboard, and attaching necessary cables to other components like the CPU, GPU, and storage drives to ensure proper power distribution.

Step 6: Power Motherboard

Power Motherboard involves connecting the motherboard to the power supply. This includes attaching the main 24-pin power connector and the CPU power connector (typically 4 or 8 pins) to ensure the motherboard receives the necessary power for operation.



Step 7: Installing Optical Drive

Installing the optical drive involves securely mounting the drive into the designated bay in the computer case, connecting it to the motherboard and power supply with appropriate cables.

Step 8: Installing the Hard Drives

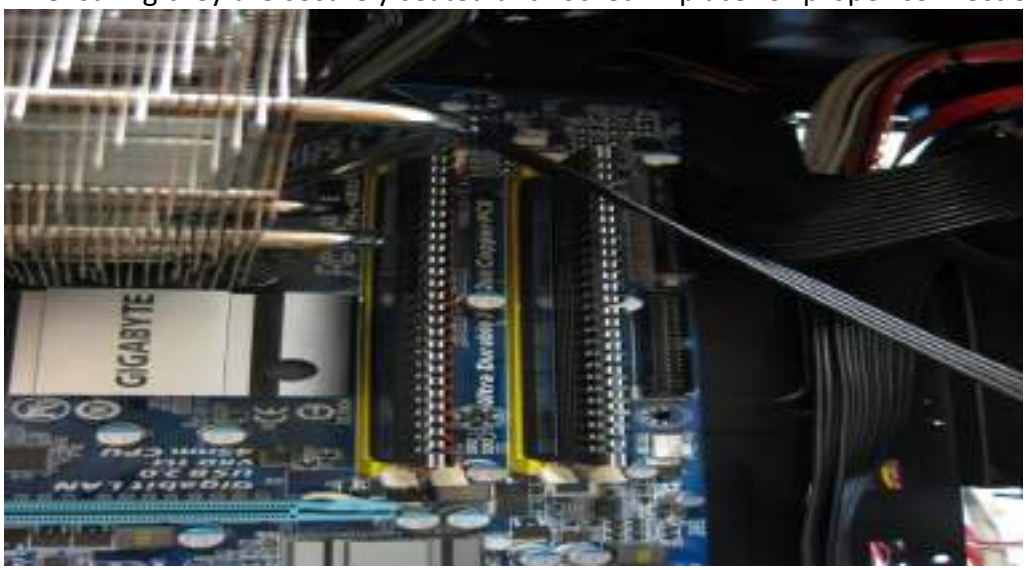
Installing the Hard Drives involves securely mounting the hard drives into the designated drive bays of the computer case and connecting them to the motherboard and power supply.

Step 9: Connect Cables

Connect Cables involves attaching various internal and external cables, such as power cables to the motherboard and storage devices, as well as data cables (SATA or IDE) to ensure proper communication and power supply between components.

Step 10: Install RAM

Install RAM involves placing RAM sticks into the motherboard's memory slots, ensuring they are securely seated and locked in place for proper connection and



performance.

Step 11: Install Graphics Card and Expansion Cards

Installing a Graphics Card and Expansion Cards involves inserting these components into the appropriate slots on a motherboard. The graphics card enhances visual output, while expansion cards add functionalities like sound, network, or additional ports. Proper alignment and securing with screws are

essential for stable operation.

Step 12: Cable Management

Cable Management involves organizing and securing cables inside the computer case to improve airflow, reduce clutter, and enhance aesthetics. This ensures efficient cooling and easier maintenance.

13: Final Product

the "Final Product" refers to the fully assembled and functional computer system, including hardware integration, operating system installation, and software setup, ready for use.

14. **Turn on desktop computer:** Press the power button on the computer case to initiate the startup process, activating the internal components.

15. **Turn on monitor:** Press the power button on the monitor to display the computer's output, allowing you to see the start-up screen and use the system.

Points to Remember

Description of desktop computer parts

1. Power Supply
2. Motherboard
3. Adapter cards
4. Internal Drives
5. Drives in external bays
6. Internal Cables
7. Display

Steps followed to connect desktop computer parts:

1. Remove side panels on case
2. Insert motherboard
3. Check clearances
4. Front panel connections
5. Install power supply
6. Power motherboard
7. Install optical drive
8. Installing the Hard drives
9. Connect cables
10. Install RAM
11. Install Graphic card and Expansion Cards
12. Cable management
13. Turn on desktop computer.
14. Turn on monitor.

Application of learning 3.2

You are an IT technician responsible for setting up new desktop computers for a small accounting firm. The firm has just hired several new employees and needs to have their workstations ready for them on their first day. Your task is to follow the necessary steps to connect the new desktop computers, ensuring they are fully operational and ready for the new hires to use.

Indicative content 3.3 Connecting Laptop Computer Parts

Duration: 4 hrs

Practical Activity 3.3.1: Connecting Laptop Computer parts

Task:

1. Referring to the **previous activity 3.2.1 and key readings 3.3.1**, you are requested to Read the given task. The task should be done **individually.**

   You are tasked with assembling all the components given to create a functioning laptop computer.

2. List out procedures followed to perform the given task
3. Present your work to the whole class
4. Ask for clarification where necessary

Key readings 3.3.1: Connecting Laptop Computer parts

Connecting Laptop Computer parts

STEPS TO CONNECT LAPTOP COMPUTER PARTS

Step 1: Gather Your Tools and Components

- **Tools Needed:**

✓ Phillips screwdriver

✓ Anti-static wrist strap (optional)

- **Components:**

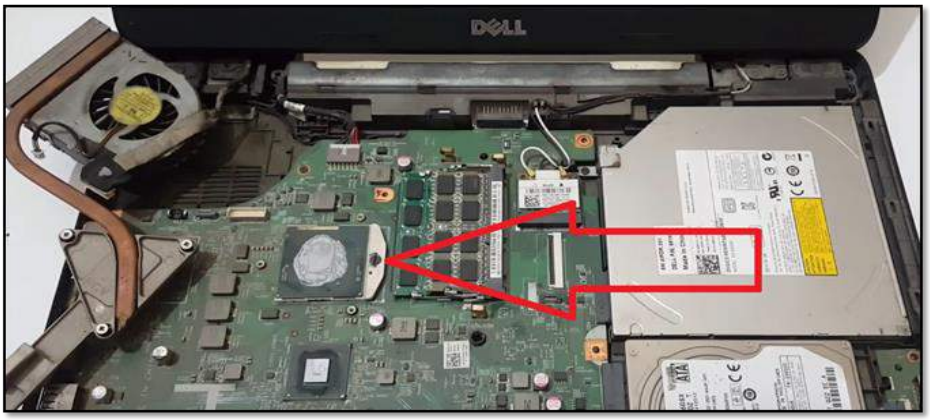
✓ Motherboard

- ✓ CPU
- ✓ RAM
- ✓ Storage (HDD/SSD)
- ✓ Battery
- ✓ Display
- ✓ Chassis

Step 2: Prepare Your Workspace

- ✓ **Clean Surface:** Ensure your workspace is clean and flat.
- ✓ **Good Lighting:** Work in a well-lit area to see small components clearly.

Step 3: Install the CPU



- ✓ **Open the CPU Socket:** Release the latch on the CPU socket on the motherboard.
- ✓ **Insert the CPU:** Align the notches on the CPU with the socket and gently place it in. Close the latch to secure it.

Step 4: Apply Thermal Paste

- ✓ **Small Dot:** Apply a small dot of thermal paste (about the size of a pea) on the center of the CPU.

Step 5: Attach the CPU Cooler

Position the Cooler: Place the cooler on top of the CPU.

- ✓ **Secure it:** Follow the cooler instructions to fasten it down.
- ✓ **Connect the Fan:** Plug the fan cable into the appropriate header on the motherboard.

Step 6: Install RAM

- ✓ **Locate RAM Slots:** Find the RAM slots on the motherboard.
- ✓ **Insert RAM:** Align the notch on the RAM stick with the slot. Push down until it clicks.

Step 7: Install Storage

- ✓ **Locate Storage Bay:** Identify where the HDD/SSD will go.
- ✓ **Mount the Drive:** If it's an M.2 SSD, insert it at an angle and secure it with a screw. For HDDs/SSDs, secure it in place using screws.

✓ **Connect Cables:** Attach the SATA cable (if required) to the motherboard.

Step 8: Install the Motherboard into the Chassis

✓ **Align Motherboard:** Carefully place the motherboard into the chassis, aligning it with standoffs.

✓ **Secure with Screws:** Use screws to fasten the motherboard to the chassis.

Step 9: Connect the Power Supply

✓ **Position Power Supply:** Place the power supply in its designated area.

✓ **Connect Power Cables:** Attach the 24-pin and any additional CPU power cables to the motherboard.

Step 10: Install the Display

✓ **Secure Hinges:** Attach the display hinges to the laptop chassis.

✓ **Connect Display Cable:** Carefully connect the display cable to the motherboard.

Step 11: Install the Battery

✓ **Locate Battery Compartment:** Find the battery slot in the chassis.

✓ **Insert Battery:** Place the battery and connect it to the motherboard.

Step 12: Assemble the Casing

✓ **Attach Bottom Cover:** Secure the bottom cover using screws or snaps.

✓ **Install Keyboard and Touchpad:** If separate, connect them to the motherboard and secure them in place.

Step 13: Final Checks

✓ **Organize Cables:** Ensure all cables are neatly connected and not obstructing any fans.

✓ **Check Connections:** Double-check that all components are securely connected.

Step 14: Power On

✓ **Plug in Power Adapter:** Connect the laptop to a power source.

✓ **Power On:** Press the power button and see if it boots up.

Tips for Practical Assembly

- **Take Your Time:** Don't rush; ensure each component is correctly placed.
- **Refer to Manuals:** Consult the manuals for specific guidance on your components.
- **Ask for Help:** If unsure, seek assistance from someone experienced.

Points to Remember

1. Gather tools and components
1. Prepare workspace
2. Install CPU
3. Apply thermal paste
4. Attach CPU cooler
5. Install RAM

6. Install storage
7. Install motherboard
8. Connect power supply
9. Install display
10. Install battery
11. Assemble casing
12. Final checks
13. Power on
14. Turn on Laptop computer.

Application of learning 3.3

Company MTT is a retail store that sells laptop computers. The company needs to ensure that all units are properly assembled before being displayed for sale. You are hired as computer system assembly technician to assemble the laptops and verify that each laptop is fully operational and ready for customers to purchase.

Indicative content 3.4: Test of Assembled Computer

Duration: 4 hrs

Theoretical Activity 3.4.1: Description of an assembled computer Testing

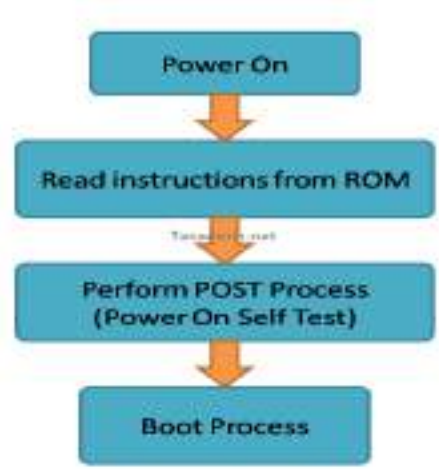
Tasks:

1. you are requested to answer the following questions related to Test of assembled computer
   i. A) What is the Power-On Self-Test (POST)
      B) What essential components does it check during the start-up process?
   ii. A) Describe the process of running POST after assembling a computer.
      B) What indicators might you observe during this diagnostic test?
   iii. A) What are beep codes, and how do they function as diagnostic signals during POST?
      B) Provide examples of common beep codes and their meanings.
   iv. Explain the role of indicator LEDs in modern computers.
   v. A) How can the BIOS manual assist in troubleshooting hardware issues during POST?
      B) What specific information can it provide regarding beep codes and LED indicators?
2. Present the findings/answers to the whole class.
3. For more clarification, read the key readings 3.4.1
4. In addition, ask questions where necessary.

Key readings 3.4.1: Description of an assembled computer Testing

Description of an assembled computer Testing

1. Running the Power-On Self-Test (POST)



- **What is POST?**

o POST (Power-On Self-Test) is the diagnostic testing sequence performed by the computer's BIOS/UEFI when the system is powered on.

o It checks essential hardware components like the CPU, RAM, motherboard, and storage devices to ensure they are functioning properly.

- **How to Run POST**

o Power on the computer after assembly by pressing the power button.

o The BIOS/UEFI will automatically initiate POST. You'll observe the process through:

- Visual output on the monitor (usually displaying the manufacturer's logo and system checks).
- Audible signals such as beeps.
- Indicator lights on the motherboard or external LEDs.

o If POST is successful, the computer will proceed to boot into the operating system. If not, errors or failure notifications will be given.

- **Troubleshooting POST Errors**

o If POST fails, the system will likely provide error codes, either visually on the screen or through audible beeps (beep codes).

o These codes help to diagnose hardware problems like missing or faulty components, memory issues, or CPU malfunctions.

2. Interpretation of Computer Beeps

- **What are Beep Codes?**

o Beep codes are diagnostic signals emitted by the motherboard's speaker during POST. Different BIOS manufacturers (like AMI, Phoenix, Award) use distinct beep code patterns.

- **Common Beep Codes and Meanings**

o **1 Short Beep**: POST completed successfully.

o **Continuous Beep**: Power supply, RAM, or motherboard issue.

o **1 Long Beep, 2 Short Beeps**: Graphics card failure.

- **3 Long Beeps**: Memory or RAM problem.
- **5 Short Beeps**: CPU issue or motherboard failure.

• **Consulting the BIOS Manual**

- Each motherboard has a manual with a section detailing specific beep codes for that BIOS version. Reference it to decode any issues.

Number of beeps	Description
1	Faulty memory refresh circuit
2	Parity error in first 64K
3	Failure in first 64K
4	System timer failure
5	CPU error—undetectable
6	BIOS cannot switch CPU into protected mode
7	CPU exception
8	Missing video adapter or faulty memory
9	ROM and BIOS checksum mismatch
10	System board can't retrieve CMOS during POST
11	Failed L2 cache; L2 cache disabled
2 short	POST failed
1 long, 2 short	Video failure—video BIOS ROM
1 long, 3 short	Video failure—video DAC, or RAM
1 long, 3 short	Convention/extended memory test failure (older BIOSs)
1 long, 8 short	Display test failure
1 long	POST passed

3. Interpretation of Computer Indicator LEDs

• **What are Indicator LEDs?**

- Most modern computers and motherboards come with built-in LED indicators that provide visual feedback about the system's status during POST and regular operation.

o These LEDs are located on the motherboard, front panel of the case, or sometimes on the peripherals.

- **Common LED Indicators**

o **Power LED**: Lights up when the system is powered on.

o **HDD/SSD LED**: Blinks when the hard drive or SSD is being accessed.

o **Network LED**: Indicates network activity.

o **Diagnostic LEDs**: Some motherboards have specific diagnostic LEDs for CPU, RAM, GPU, and storage components.

- **LED Interpretation**

o **Solid or Blinking Lights**: LED status can indicate normal operation (solid light) or an error (blinking or red light).

o **No Light**: Might indicate that the component is not functioning or not connected properly.

Practical Activity 3.4.2: Testing of assembled computer

Task:

1. Referring to **key reading 3.4.2,** you are requested to read the given task. The task should be done **individually.**

You have finished assembling a computer and need to ensure that all components are working correctly. Your task is to run diagnostic tests to verify the system's functionality using the Power-On Self-Test (POST), beep codes, and indicator LEDs.

2. List out procedures followed to perform the given task

3. Referring to procedures provided above, Perform the required task

4. Present your work to the trainer

Key readings 3.4.2: Testing of assembled computer

STEPS FOR TESTING AN ASSEMBLED COMPUTER

Testing an assembled computer involves several steps :

1. Running the Power-On Self-Test (POST)

POST is an initial diagnostic test performed by the BIOS when the computer is powered on. It checks for hardware issues and ensures all critical components are functioning.

Steps:

- Power up the system by pressing the power button.

- Observe the monitor for any POST messages or errors. These messages typically include system information, hardware status, or error codes if something is wrong.
- The system should proceed smoothly to the BIOS/UEFI screen or boot to the operating system if the POST passes.

Possible POST results:

- **Successful POST:** The system will either display the BIOS screen or load the operating system.
- **POST failure:** A black screen, error codes, or beeps may indicate an issue.

2. Interpretation of Computer Beeps

The beeping sounds during POST can help you identify hardware issues, especially if the system fails to boot. Different BIOS manufacturers use different beep codes to signify errors.

Steps:

- Count the number and pattern of beeps after powering on the computer.
- Check the beep code chart specific to your motherboard or BIOS manufacturer (e.g., AMI, Award, Phoenix) for error interpretation.

Common beep code interpretations:

- **1 short beep:** System is normal (successful POST).
- **2 short beeps:** General POST error, often non-critical.
- **1 long, 2 short beeps:** Video card error.
- **Continuous beeping:** RAM issue (improper seating, defective modules).
- **No beeps:** Power issue, dead motherboard, or faulty CPU.

Tip: Refer to the motherboard's manual for the exact meaning of the beep codes, as they vary.

3. Interpretation of Computer Indicator LEDs

Modern motherboards and cases often include status LEDs that can give quick insights into the health of different hardware components.

Steps:

- Check the front panel indicator LEDs (usually found on the computer case) when you power up the system.
  - **Power LED:** Indicates that the system is receiving power.
  - **Hard Drive LED:** Flashes when the hard drive is being accessed.

- **Error LEDs (if available):** Some high-end systems have LEDs that indicate specific hardware issues like CPU, RAM, or GPU problems.
- Observe any onboard diagnostic LEDs on the motherboard itself (common in newer models):
- **CPU, RAM, VGA LEDs:** May remain lit to signal an issue with these components.
- **Power and Reset LEDs:** Confirm that power is being supplied correctly.

Common LED interpretations:

- **Solid power LED: System is powered on.**
- **Blinking power LED:** The system is in sleep mode or experiencing power-related issues.
- **Hard drive LED off/no activity:** Could indicate a storage issue or an improperly connected drive.
- **Motherboard diagnostic LEDs lit:** Point to the faulty component (CPU, RAM, GPU, etc.).

Points to Remember

Power-On Self-Test (POST)

- **POST** checks hardware like CPU, RAM, and storage when the computer powers on.

Running POST

1. **Power on** the system.
2. **POST runs** automatically, visible through:
   - Screen output.
   - Beep sounds.
   - LED indicators.
3. A successful POST leads to booting; failures show errors or beeps.

Beep Codes

- **Beep codes** signal hardware problems. Each BIOS manufacturer has unique codes.

Common Codes:

- **1 Short Beep**: Successful POST.

- **Continuous Beep**: Power or motherboard issue.
- **1 Long, 2 Short**: GPU failure.
- **3 Long**: RAM issue.
- **5 Short**: CPU/motherboard failure.

Indicator LEDs

- **LEDs** give system status during POST and operation.
    - **Power, Storage, Network, Diagnostic LEDs** show specific hardware status.

STEPS FOR TESTING AN ASSEMBLED COMPUTER

1. **Run POST:**
    - Turn on the system and observe if it passes POST.
    - Check for on-screen messages or error codes.
2. **Interpret Beep Codes:**
    - **L**isten for beep patterns and check them against the motherboard's manual for error identification.
3. **Interpret Indicator LEDs:**
    - Check the status of the power, hard drive, and error LEDs on the case.
    - Look for diagnostic LEDs on the motherboard for specific hardware issues.

Application of learning 3.4

You have just assembled a new desktop computer for a client. Before delivering the computer, you need to perform a series of tests to ensure that all components are functioning correctly. This will involve running the Power-On Self-Test (POST), interpreting any diagnostic signals, and troubleshooting any issues that may arise. Your goal is to confirm that the system is fully operational and meets the client’s requirements.

Indicative content 3.5: Documentation of Assembly Report

Duration: 4 hrs

Theoretical Activity 3.5.1: Documentation of Assembly report

Tasks:

1. you are requested to answer the following questions related to the documentation of As sembly report
   I. Why is it important to document the assembly process of a computer system?
   II. Describe at least three benefits of maintaining accurate documentation for both the technician and the client.
   III. List and describe the key components that should be included in a comprehensive assembly report for a computer system.
   IV. Outline the process for creating a sample assembly report
2. Write answers to the questions on provided flipchart or papers.
3. Discuss on the provided answers and choose correct answers
4. For more clarification, read the **key readings 3.5.1.** and ask questions where necessary.

Key readings 3.5.1: Documentation of Assembly report

Assembly report

The assembly report serves as a vital record for any project that involves the physical assembly of components. It provides a structured framework of information and instructions that ensures the process can be replicated accurately, guarantees product quality, and allows for tracing all actions back to the source for accountability and troubleshooting.

1. **Step-by-Step Instructions**:

o Assembly documentation provides detailed step-by-step instructions that guide workers through the process of assembling a product. These instructions are typically written in a clear, concise manner to ensure that even those with minimal technical knowledge can follow them correctly.

o Each step is typically accompanied by diagrams, pictures, or visual aids to clarify any complex processes.

2. **Quality Assurance (QA)**:

o The documentation establishes standard procedures, helping maintain consistency in assembly, thus reducing errors and ensuring high-quality outputs.

- It includes quality control checks at critical stages, specifying what to inspect and how to document findings to ensure the product meets specified standards.

3. **Traceability**:

- The documentation ensures traceability by recording each stage of the assembly process, including any parts or materials used, steps followed, and tests conducted.
- This allows for auditing the assembly process and identifying where potential issues may have occurred.

Components of an Assembly Report

A well-organized assembly report typically contains the following components:

1. **Title Page**

- **Content:** Includes essential details like the project name, the date of documentation, the name(s) of the author(s), the version number of the report, and a project or assembly identification code.
- **Purpose:** Acts as the cover and gives the reader a clear understanding of what the document pertains to.

2. **Table of Contents (TOC)**

- **Content:** A structured outline of all sections in the report, allowing the reader to quickly navigate the document.
- **Purpose:** Facilitates ease of use, particularly for lengthy or complex reports where the reader needs to access specific sections.

3. **Assembly Instructions**

Content:

- Step-by-step instructions for assembling the product, starting from component preparation to final assembly.
- **Visual aids** such as diagrams, flowcharts, or images are critical, especially when dealing with intricate components or complicated steps.

Details to include:

- **Clear description of each step:** Specific tasks to be performed, components involved, and exact locations where they need to be placed.

- **Safety instructions:** Safety measures to follow while assembling to prevent damage to components or harm to the worker.
- **Tools Required:** A list of specific tools needed for each step.
- **Estimated time per step:** A breakdown of how long each step should take to maintain an efficient assembly process.

4. **Materials List**

Content:

- A detailed list of all parts, components, and materials required for the assembly.
- **Part numbers:** Every part should have its corresponding part number and supplier details.
- **Quantity needed:** Specify the exact number of units required for each part.

- **Purpose:** Helps ensure that all necessary materials are available before assembly begins, reducing downtime and ensuring smooth workflow.

5. **Testing Procedures**

Content:

- Detailed instructions for testing the assembled product to ensure functionality.
- **Types of tests:** Electrical testing, mechanical inspections, or software configurations might be required depending on the type of product.
- **Test environment requirements:** Voltage levels, conditions, or external devices needed for testing.

- **Purpose:** To confirm the product works as intended and meets performance criteria before it is deployed or sent to customers.

6. **Troubleshooting Guide**

- **Content:**
  - A section that lists potential problems that could arise during or after the assembly.
  - **Symptoms:** Describe common issues (e.g., "Computer won't power on").
  - **Causes:** Outline possible causes for each issue (e.g., "Check if the PSU is properly connected").
  - **Solutions:** Provide clear, actionable steps to resolve the issues (e.g., "Reconnect the 24-pin ATX power connector").

- **Purpose:** Helps assemblers quickly identify and fix issues during the assembly process or during post-assembly testing.

Practical Activity 3.5.2: Create Assembly report

Task:

1. Referring to **key readings 3.5.2**, you are requested to read the given task. The task should be done **individually.**
   You have just completed assembling a desktop computer for a client. Your next task is to prepare a comprehensive assembly report documenting the entire process.
2. List out procedures followed to perform the given task
3. Present your work to the trainer and whole class
4. Ask for clarification where necessary

Key readings 3.5.2: Create Assembly report

Steps to Prepare Documentation of an Assembly Report

Creating a thorough assembly report is crucial for maintaining a record of the process, troubleshooting, and presenting the results of a successful assembly. Below are the detailed steps to prepare such a report:

1. **Prepare the Report Template**

- **Choose a Format:** Decide on a standard document format such as Word, PDF, or a shared document template. This should include key sections like cover page, introduction, assembly details, and conclusion.
- **Consistent Layout:** Ensure uniform formatting, such as font type, size, headings, subheadings, margins, and page numbering.
- **Section Headings:** Use the following sections:
  - Cover Page
  - Table of Contents (if the report is lengthy)
  - Introduction
  - Assembly Details
  - Testing and Verification
  - Issues and Resolutions

- Conclusion
- Attachments

2. **Gather Information**

Before drafting the report, gather and document all necessary details about the assembly process.

Document Assembly Details:

- **Component List:** Record all components used (e.g., CPU, motherboard, GPU, RAM) including brand, model, serial number, and specifications.
- **Assembly Procedure:** Provide a step-by-step guide on how each part was assembled, including the method, tools used, and photos or diagrams for clarity.
- **Special Configurations:** Note any special settings, such as BIOS adjustments, overclocking, or specific hardware arrangements.
- **Record Testing and Verification:**
- **Initial Boot Test:** Document the first power-on or boot attempt and any issues that arose.
- **Functional Testing:** Record results from tests like POST (Power-On Self-Test), performance benchmarks, and stress tests.
- **Peripheral Testing:** Check functionality for attached peripherals (e.g., keyboard, mouse, monitor) and ensure everything is detected correctly.
- **Verification Tools:** List any tools or software used for testing, such as diagnostic utilities or benchmarking tools.
- **Log Issues and Resolutions:**
- **Identify Problems:** Log any issues faced during assembly or testing (e.g., missing screws, component failures, wiring issues).
- **Troubleshooting Steps:** Include detailed notes on how each problem was identified, investigated, and resolved.
- **Solutions Applied:** Document any hardware changes, software updates, or configuration tweaks that were necessary to fix the issues.

3. **Create the Report**

Now that the information has been gathered, you can start drafting the assembly report using the template.

- **Cover Page:**
- Include the title of the report (e.g., "Desktop Computer Assembly Report"), your name, date, and any relevant project identifiers.

- **Introduction:**
- Provide an overview of the project, outlining the purpose of the assembly (e.g., building a gaming PC, testing hardware configurations) and the intended outcome.
- Briefly mention the components and tools used.
- **Assembly Details:**
- **Step-by-Step Process:** Write in-depth descriptions of the assembly process. Each section should clearly describe actions taken, such as installing the CPU, mounting the motherboard, or connecting cables.
- **Visual Aids:** Use photos or diagrams for each major step, especially for tricky tasks like applying thermal paste or securing the power supply.
- **Configurations:** Record any specific settings or customizations made, such as BIOS changes or overclocking adjustments.

Testing and Verification:

- **Testing Procedures:** List the steps taken to test the system. Include diagnostics run on the hardware components (e.g., memory testing, CPU stress testing).
- **Performance Results:** Summarize performance data from benchmarking software (e.g., FPS in games, read/write speeds for storage drives).
- **Verification of Functionality:** Confirm that all components are functioning correctly and list any anomalies discovered during testing.
- **Issues and Resolutions:**
- **Challenges:** Document any problems encountered during the assembly process or testing, such as hardware compatibility issues, failed boots, or software glitches.
- **Troubleshooting Process:** Provide detailed steps on how you investigated and fixed each issue, including what resources you used (e.g., forums, technical manuals).
- **Conclusion:**
- Summarize the outcomes of the assembly and testing. Mention whether the system performed as expected, highlight key findings, and provide any recommendations for future builds.
- **Attachments:**
- Include any additional documents such as:
    - **Component Datasheets:** Specifications for each part.
    - **Test Results:** Detailed test logs or screenshots of benchmark scores.
    - **Warranty Information:** Documents related to the components' warranty or return policies.

4. **Review and Revise**

- **Proofreading:** Check for grammatical errors, consistency in formatting, and technical accuracy.
- **Check Completeness:** Ensure all steps in the assembly are covered, and each issue encountered has a corresponding resolution.
- **Feedback:** Consider getting feedback from a peer or supervisor to verify technical accuracy and clarity.
- **Verify Data:** Double-check any testing data or benchmark results to ensure that they are accurate and representative.

5. **Prepare for Submission**

- **Finalize the Document:** Ensure that the report is properly formatted and free of any errors.
- **Save Multiple Formats:** Save the document in the required formats (e.g., PDF for official submission and DOCX for editing).
- **Include Necessary Attachments:** Ensure that all referenced attachments (test results, diagrams) are included and correctly linked or labeled.
- **File Naming Convention:** Follow any specific file naming guidelines, if applicable, for submission.

6. **Reflect and Learn**

- **Review the Process:** After submitting the report, reflect on the assembly process and the report preparation.
- **Identify Strengths and Areas for Improvement:** Consider what went well (e.g., timely completion, successful troubleshooting) and identify areas where improvements can be made in future builds.
- **Learning from Feedback:** Incorporate any feedback received from peers or reviewers into future assembly reports.
- **Document Lessons Learned:** Record key takeaways from the assembly and reporting process that can be applied to future projects (e.g., specific testing methods, better tools, or more efficient steps).

Points to Remember

Steps to create Assembly report

1. Prepare the Report Template
2. Gather Information

- Document Assembly Details
- Record Testing and Verification
- Log Issues and Resolutions

3. Create the Report

- Cover Page
- Introduction
- Assembly Details
- Testing and Verification
- Issues and Resolutions
- Conclusion
- Attachments

4. Review and Revise
5. Prepare for Submission
6. Reflect and Learn

Application of learning 3.5

Prepare a comprehensive assembly report for the computer you assembled. Your report should include a cover page, an introduction, detailed assembly steps, testing and verification results, any issues encountered and their resolutions, and a conclusion. Ensure your report is well-organized. Describe the key elements you included in the report and explain how each contributes to a complete and effective documentation.

Learning outcome 3 assessment

1. What does computer hardware refer to?
a) The software applications on a computer
b) The physical parts of a computer and related devices
c) The operating system
d) None of the above
2. Which of the following is an example of an output device?
a) Mouse
b) Scanner
c) Printer
d) Touchpad
3. What is the primary function of storage devices?
a) To process data
b) To display information
c) To retain data and programs for future use
d) To input data
4. Which storage device offers faster data access compared to a Hard Disk Drive (HDD)?
a) USB Flash Drive
b) Optical Disc
c) Solid-State Drive (SSD)
d) External Hard Drive
5. What is the main component responsible for processing instructions in a computer?
a) Motherboard
b) Central Processing Unit (CPU)
c) Graphics Processing Unit (GPU)
d) Hard Drive
6. Where is the power supply unit (PSU) typically installed in a desktop case?
A) Front panel
B) Top or bottom rear
C) Side panel
D) Inside the motherboard
7. Which connector provides power to the motherboard?
A) 4/8-pin CPU power connector
B) 24-pin ATX connector
C) SATA power connector
D) PCIe power connector
8. Which connection is used to link the monitor to the desktop?
A) USB

B) VGA,
C) SATA
D) Ethernet

9. Which type of cable is used to connect storage devices to the motherboard?

a) Power cables
b) SATA data cables
c) HDMI cables
d) USB cables

Q10. Match the items in Column A with their corresponding descriptions in Column B.

Column A	**Column B**
1. Motherboard	A. Provides protection and support for internal components.
2. CPU	B. Main circuit board that connects all internal components.
3. RAM	C. Stores temporary data for quick access by the CPU.
4. Hard Drive (HDD/SSD)	D. Primary storage device for operating system and files.
5. Battery	E. Supplies power to the laptop when not plugged in.
6. Display Screen	F. Visual output device for user interaction.
7. Lid	G. Closes the laptop and protects the screen and internal parts.
8. Keyboard	H. Input device for typing and commands.
9. Touchpad	I. Pointing device for cursor control.
10. Cooling System	J. Maintains optimal temperature for internal components.

Answer the following questions by true or false

1. POST (Power-On Self-Test) is performed by the computer's BIOS/UEFI to check essential hardware components.
2. If POST is successful, the computer will not proceed to boot into the operating system.
3. Beep codes are unique to each BIOS manufacturer and help diagnose hardware issues during POST.
4. Indicator LEDs on a motherboard only indicate network activity and do not provide information about other hardware components.

Fill-in-the-blank with the correct answers

1. The assembly report serves as a vital record for any project that involves the physical assembly of components, providing a structured framework of information and _____ that ensures the process can be replicated accurately. (A) instructions (B) accountability (C) guidelines
2. Quality assurance documentation includes _____ checks at critical stages, specifying what to inspect and how to document findings to ensure the product meets specified standards. (A) design (B) quality (C) performance
3. A well-organized assembly report typically contains a title page, table of contents, assembly instructions, a materials list, testing procedures, and a _____ guide to address potential problems. (A) troubleshooting (B) maintenance (C) support
4. The assembly instructions section must include clear descriptions of each step, safety instructions, tools required, and _____ time estimates for each part of the assembly process.
   (A) maximum (B) estimated (C) required

Practical assessment

You are participating in a training workshop at a computer assembly facility, where you will assemble both desktop and laptop computers. After properly assembling each unit, you will conduct tests to ensure they are fully operational. Finally, you will document your findings in a report, including model specifications, a checklist of components, test results, and any issues encountered, confirming that each unit is ready for sale., this task should be completed within 4 hours

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